ice Abstracts

Section A

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CONTENTS

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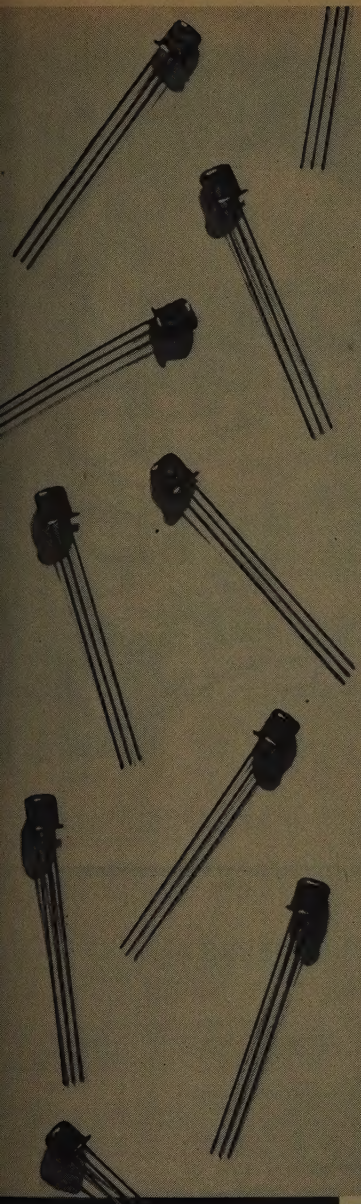

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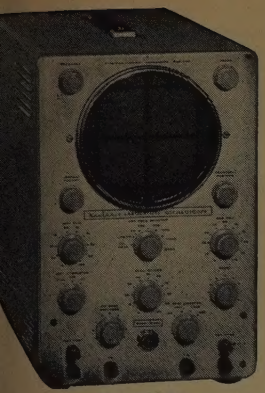

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dio Wattmeter, AW-1U. Power range 5 mW—50 W f.s.d. quency response 10 c/s to 250 Kc/s ± 1 dB. Internal load resis-s 3, 8, 15 and 600 ohms ± 1% non-inductive and switch selected. ver ratings 25 watts continuous, 50 watts inter-tent. 4½" meter with 200 μA movement **£14.14.0**

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PHYSICS ABSTRACTS

ume 64 OCTOBER 1961 Number 766

MATHEMATICS

671 CALCULATION OF THE MEAN VALUES OF FUNCTIONS OF DISTANCE FROM A POINT OVER A SURFACE OR LUME. G.A.Grinberg.
ekh. Fiz. (USSR), Vol. 31, No. 1, 3-12 (Jan., 1961). In Russian.
For abstract, see Abstr. 5114 of 1961. [English translation in:
et Physics—Technical Physics (USA), Vol. 6, No. 1, 1-7
, 1961)].

APPLICATIONS OF MELLIN TRANSFORMS TO SOME PROBLEMS OF STATISTICAL MECHANICS. See Abstr. 11715

INTEGRATION OF ROTATION ABOUT THE CENTRE OF GRAVITY IN A SIMULATOR. See Abstr. 11730

ESTIMATED COLLISION INTEGRALS FOR THE EXPONENTIAL ATTRACTIVE POTENTIAL. See Abstr. 11786

ASTROPHYSICS

672 DYNAMICS OF THE UNIVERSE.
J.Pachner.
phys. Polon. (Poland), Vol. 19, No. 6, 663-73 (1960).
The dynamical law of the universe is deduced from three le and plausible principles without using the energy momentum r of continuous matter. It is shown that the square of Hubble's r may be interpreted as proportional to a certain density of r which is transformed during the expansion of the universe rest mass (in form of the evolution of new nebulae and stars) nto different forms of energy. The maximal radius of the rse is reached when all Hubble's mass is consumed. During ubsequent contraction the stars and nebulae are destroyed by ging their rest mass into Hubble's mass. At the moment of mal contraction all the mass exists only in the form of le's mass. This process repeats itself from infinity to infinity. computed numerical values of the radii of the universe, of its mass, and of its age are of the plausible orders of magnitude. also proved that the proper meaning of the well-known cosmol- l constant is that the density of total matter remains constant se of continuous creation of matter from nothing. An example ch a universe with continuous creation of matter is the tter universe.

673 THE ORIGIN OF LUNAR DOMES.
J.W.Salisbury.
phys. J. (USA), Vol. 134, No. 1, 126-9 (July, 1961).
Three previously suggested hypotheses of origin for lunar s are reviewed, and a new one is suggested. The former three heses include volcanic, gas-bubble, and laccolithic origins for domes. The new hypothesis suggests mineral-phase-change sion. It is demonstrated that serpentinization of olivine below C involves approximately a 25% increase in volume, which would ore than adequate to produce domical structures.

674 ON POSSIBLE PARENT SUBSTANCES FOR THE C_2 MOLECULES OBSERVED IN THE ALPHONSUS CRATER.
Urey.
phys. J. (USA), Vol. 134, No. 1, 268-9 (July, 1961).

675 ON THE STUDY OF COMET TAILS AND MODELS OF THE INTERPLANETARY MEDIUM. J.C.Brandt.
phys. J. (USA), Vol. 133, No. 3, 1091-2 (May, 1961).
A theoretical expression for h, the component of the tail in irection of the extended radius vector divided by the component e direction of the orbit behind the comet, is used to compute h omets 1954 h and k employing Parker's (1960) and mberlain's (1961) models of the interplanetary medium. It is that Chamberlain's model would appear to fit the observations
M.Kasha

11676 THE ORBIT OF COMET SCHWASSMANN-WACHMANN 1.
P.Herget.
Astron. J. (USA), Vol. 66, No. 6, 266-71 (Aug., 1961).
A numerical integration and orbit correction for Comet Schwassmann-Wachmann 1925 II reveals the existence of non-gravitational forces acting upon the comet. The comet approaches within 1 a.u. of Jupiter in 1974, and drastic changes in the elements will be produced. Extended opposition ephemerides are furnished until 1973.

11677 THE COEFFICIENT OF THERMAL CONDUCTIVITY IN THE SUN'S ATMOSPHERE.
F.Q.Orrall and J.B.Zirker.
Astrophys. J. (USA), Vol. 134, No. 1, 63-71 (July, 1961).
Expressions for the coefficients of thermal conductivity and viscosity for a partially ionized mixture of hydrogen and helium are given as functions of the number densities of the particles and the temperature. Such expressions are required for energy-balance studies, since it is well known that, over much of the sun's atmosphere, ionization is far less advanced than one would predict from the Saha formula. The effect of a magnetic field on the thermal conductivity is discussed. It is pointed out that in the presence of a transverse magnetic field, even for a nearly ionized gas, the conduction of heat may be due almost entirely to the neutral particles. A sample calculation is given for physical conditions in a prominence.

11678 A BASIC LIMIT OF THE INFORMATION CONTAINED IN CENTER-TO-LIMB OBSERVATIONS. K.H.Böhm.
Astrophys. J. (USA), Vol. 134, No. 1, 264-7 (July, 1961).

11679 GRANULATION NEAR THE EXTREME SOLAR LIMB.
R.E.Loughhead and B.J.Bray.
Austral. J. Phys., Vol. 13, No. 4, 738-9 (Dec., 1960).
In an attempt to resolve the contradictory results of Rösch (1957) and Edmonds (1960) regarding the angular distance from the solar limb at which just-resolvable granulation can be perceived, high-quality photographs taken with a specially designed 5 in. photoheliograph (Loughhead and Burgess, 1958) during the past three years were enlarged, and examined critically. Granulation was found within 10" of arc of the limb (in one case, a single granule was seen only 4" away). The results do not support Edmonds' contention that the granules disappear completely at 21" from the limb. They agree with those of Rösch who found the granulation to be visible to within 10" to 5" of arc from the solar limb.
D.R.Barber

11680 HEAT CONDUCTION AND THE FINE STRUCTURE OF SOLAR PROMINENCES. I. OPTICALLY THIN MODEL PROMINENCES. F.Q.Orrall and J.B.Zirker.
Astrophys. J. (USA), Vol. 134, No. 1, 72-84 (July, 1961).

It is found that large portions of some quiescent prominences may remain with no detectable change in the form and brightness of their threadlike fine structure for as long as 10^4 sec. Since this is at least one hundred times longer than the time required for the prominence to radiate its internal energy, a steady source of energy input is implied. The possibility is investigated that quasi-static equilibrium is set up everywhere in a prominence thread between radiative losses and energy supplied by the coronal heating source and distributed by heat conduction. Transparency in all radiations and constant pressure are assumed. When the effect of the magnetic field on the thermal conductivity is considered, the computed model prominences are much too narrow. It is suggested, however, that when the opacity of prominence material is taken into account, the computed models will be in much better agreement with observations.

11681 PARALLAX AND ORBITAL MOTION OF 42 COMAE = ADS 8804 FROM PLATES TAKEN WITH THE 24-INCH SPROUL REFRACTOR. S.L.Lippincott.
Astron. J. (USA), Vol. 66, No. 6, 272-3 (Aug., 1961).

Measurement and reduction of plates taken with the Sproul refractor over the interval 1920-1959 yield +".038 ± ".005 (p.e.) for the relative parallax and +".008 ± ".010 (p.e.) for the semi-axis major of the photocentric orbit of 42 Comae. The relative mass of the B component is .507 ± .014 (p.e.), whereas the individual masses are poorly determined due to the small value of the parallax: $M_A = 1.6\odot$. $M_B = 1.7\odot$ each with a p.e. of ± .45 ⊙.

ANNIHILATION PROCESS OF NEUTRINO PRODUCTION IN STARS. See Abstr. 10875

11682 THE FORNAX DWARF GALAXY. II. THE DISTRIBUTION OF STARS. P.W.Hodge.
Astron. J. (USA), Vol. 66, No. 6, 249-57 (Aug., 1961).

For Pt I see Abstr. 5164 of 1961. From counts of 60 000 stars in the neighbourhood of the Fornax dwarf galaxy, the distribution of the projected stellar density in the galaxy is derived. It is found to be smooth, with its ellipticity averaging about 0.35, and with some asymmetry in the central region. The density profile falls off more rapidly with distance than Hubble's interpolation formula for giant ellipticals. This is interpreted as the result of the gravitational influence of the Galaxy on the outer stars of the Fornax dwarf. From estimates of the mass of Fornax it is found that the predicted tidal limiting radius is in reasonable agreement with that observed. There does not appear to be any general obscuration within the galaxy; distant galaxies are distributed uniformly behind it.

Radioastronomy

11683 SOLAR EMISSION AT MILLIMETER WAVE LENGTHS. C.W.Tolbert and A.W.Straiton.
Astrophys. J. (USA), Vol. 134, No. 1, 91-5 (July, 1961).

This paper describes recent measurements of the solar flux density at several wavelengths between 4.3 and 2.15 mm. The results of the measurements indicate that the radiation is primarily from the photosphere and is of a thermal nature, corresponding to that of a black body at a temperature of 6000°K. There are, however, meaningful differences in the solar emission temperatures reported by several investigators that indicate the possibility of gray-body emission characteristics at the millimetre wavelengths.

11684 SOME STUDIES ON THE OCCURRENCE OF TYPE IV SOLAR BURSTS OF CONTINUUM RADIATION. M.R.Kundu.
Astrophys. J. (USA), Vol. 134, No. 1, 96-104 (July, 1961).

It is shown that type IV emission in the range of frequencies 25-580 Mc/s occurs in two distinct phases: (a) The first phase, usually observed at frequencies higher than about 250 Mc/s, appears to be an extension of the associated centimetre-wave burst which is also a broad-band continuum emission. This emission occurs earlier than the associated type II burst and can even occur independent of any type II burst. The source of this emission is situated low in the chromosphere, has no significant movement, and has a small angular size, usually less than 4'. The observed properties of this phase of continuum emission are consistent with the suggestion that that it is caused low in the chromosphere by synchrotron radiat of electrons generated during the flare. (b) The second phase, usually observed at frequencies lower than about 250 Mc/s, is closely associated with a type II burst preceding it. The source this continuum emission is situated high in the corona and move with velocities of more than 1000 km/sec. It has a large angul size, usually 10' or larger. This second phase of type IV emiss was previously explained as due to synchrotron radiation of ele rons higher in the corona, when a cloud of gas with a shock fro (which excites the type II burst) moving at high velocities carri a frozen-in magnetic field to the appropriate heights in the cor

11685 RECENT DECAMETER-WAVE-LENGTH OBSERVATIONS OF JUPITER, SATURN, AND VENUS. T.D.Carr, A.G.Smith, H.Bollhagen, N.F.Six, Jr and N.E.Chatter
Astrophys. J. (USA), Vol. 134, No. 1, 105-25 (July, 1961).

Decametre-wavelength radio observations of Jupiter, Satur and Venus were made at a number of frequencies from both Northern and Southern hemispheres of the earth during 1959 an 1960. While the results are negative for Venus and inconclusive Saturn, extensive non-thermal radio noise was recorded in the of Jupiter. The observations permitted a redetermination to be made of the rotational period of the Jovian radio sources, and a statistical analysis was made of the polarization of the noise bu Jupiter radio outbursts showed a maximum probability of occur near a frequency of 18 Mc/s, with individual pulses displaying spectral widths of less than 1 Mc/s. Over-all Jovian activity showed an inverse correlation with sunspot number, although th is evidence that individual noise storms may be triggered by so particles. Photoelectric observations made of Jupiter during r noise storms showed no light-variations within the sensitivity l of the equipment used.

11686 NOISE SUPPRESSION IN PULSE RECEIVERS. E.C.McLauchlan.
Austral. J. Phys., Vol. 13, No. 4, 750-2 (Dec., 1960).

In the course of measuring Southern Hemisphere meteor ra by radar methods, difficulty has been experienced in combating effect on the meteor rate of a variable background, due to noise both solar and man-made origin. A serious shortcoming of the fairly standard measuring system is that any appreciable rise i background noise results in excess darkening of the film, and h lowered recognition of echoes. The incidence of total black-out to man-made interference was greatly reduced by the inclusion compression amplifier in the video section of the receiver. Th compression amplifier is described with the aid of circuit diagr The method of a test is discussed, and results given. The plate shows clearly the increased readability of echo rates during pe of high noise, while those obtained during periods of low noise a unaffected. G.C

11687 PECULARITIES OF THE RADIO RADIATION OF NGC 4486. Yu.N.Pariiskii.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 1, 49-50 (March 1, 1961). In Russian.

For abstract, see Abstr. 10396 of 1961. [English translatio in: Soviet Physics – Doklady (USA), Vol. 6, No. 3, 184-6 (Sept., 1961)].

Space Research

11688 THE MOTION OF A HYPERBOLIC ARTIFICIAL SATELLITE AROUND THE OBLATE EARTH. G.H
Astron. J. (USA), Vol. 66, No. 6, 258-63 (Aug., 1961).

The first-order perturbation of the oblateness of the earth the hyperbolic motion of an artificial satellite is developed by t von Zeipel method. The theory is valid for any eccentricity gr than unity and for any inclination. The modification of the Dela variables and the meaning of integration constants are discusse some detail.

11689 APPENDIX TO THEORETICAL EVALUATION OF ATMOSPHERIC DRAG EFFECTS IN THE MOTION AN ARTIFICIAL SATELLITE. D.Brouwer and G.Hori.
Astron. J. (USA), Vol. 66, No. 6, 264-5 (Aug., 1961).

For previous work see Abstr. 9295 of 1961. Presents an approximation to $\exp(-\theta)$ in powers of θ that is more convergen than a Taylor's series development if θ is limited to a given ra

1690 RELATIVE INTENSITIES OF Na LINES IN THE EMISSION OF SODIUM FROM ROCKETS.
ssy and E.Vassy.
et. Space Sci. (GB), Vol. 2, No. 1, 71-2 (Oct., 1959).
Preliminary photographic intensity measurements on the 3303A and 5893A Na lines excited at twilight and dawn from Na clouds liberated from French rockets of March 10 and 12 over the Sahara. No definite conclusions on excitation mechanisms could be drawn from the provisional intensity ratio. R.W.Nicholls

PHYSICS

GENERAL

691 TIME REVERSAL AS AN OPERATION OF ANTI-SYMMETRY. A.V.Shubnikov.
allografiya (USSR), Vol. 5, No. 2, 328-33 (March-April, 1960).
ssian.
A discussion of the meaning of numbers with and without sign. e is regarded as a magnitude without sign since if there can be ch thing as negative time it is meaningless to regard time as ive. Time reversal therefore is without meaning and it is ed out that in the magnetic symmetry groups of crystals, the ation of anti-identity is performed by a change in direction of ent which bears no relation to time reversal. (See Abstr. 11820 60). [English translation in: Soviet Physics—Crystallography), Vol. 5, No. 2, 309-14 (Sept.-Oct. 1960)]. J.Iball

1692 ON NON-LINEAR FIELD THEORY. J.Lindner.
turforsch. (Germany), Vol. 16a, No. 4, 346-56 (April, 1961).
erman.
Methods are developed for solving the field equations of the linear field theory of Bechert, describing static charge and s distributions in interaction with electrostatic and gravitational s. A particular solution leads to the statistical model of omb charges held together by gravitational forces (see Abstr. of 1961). There are many-particle models only when all icles are equally charged. The difficulties in a dynamical ry cannot be overcome in the present unquantized form of the ry. Finally a rotating charge distribution, the classical analogue in, is discussed. E.J.Squires

A SYSTEM FOR RECORDING AND INTEGRATING PHYSICAL ASUREMENTS. See Abstr. 11890

GRAVITATION . RELATIVITY

1693 DEFLEXION OF LIGHT IN THE GRAVITATIONAL FIELD OF THE SUN. N.S.Japolsky.
re (GB), Vol. 189, 651-2 (Feb. 25, 1961).
In an application of the author's electromagnetic whirl theory ght and gravitation (Abstr. 7507 of 1951), the deflection is d to depend upon wavelength but a mean value is obtained in e agreement with relativistic theory. R.A.Newing

1694 ENERGY—MOMENTUM CONCEPTS OF THE GRAVITATIONAL FIELD. K.Kraus.
hys. (Germany), Vol. 163, No. 2, 240-4 (1961). In German.
From translational invariance one has essentially two possib-es for energy—momentum concepts of gravitation: the pseudo-or found by Einstein and an concept similar to that Møller tr. 26 of 1959). The author prefers the latter not only because s more reasonable properties, but also from a more axiomatic t of view. A difference of the present work from that of er and another ("purely canonical") formulation of the con-ation theorem are pointed out.

1695 THE SPECIAL THEORY OF RELATIVITY. H.Dingle.
ed. London: Methuen; New York: John Wiley (1961) xiii + 94 pp.
A reissue of this well established book in which the theory is ented as a generalization from experiment. A long preface has added in this edition. The author is convinced that the theory longer tenable and he explains the present position in relation is presentation.

696 OBSERVATION OF A TIME INTERVAL BY A SINGLE OBSERVER. A.D.Crowell.
r. J. Phys., Vol. 29, No. 6, 370-1 (June, 1961).
It is known that the appearance of a moving body in special relativity is not given by the Lorentz transformation, since light signals from different parts of the body take different lengths of time to reach the observer. The corresponding effect for the observation of a time interval in a moving system is examined here. It is related to the Doppler effect. O.Penrose

11697 VELOCITY OF LIGHT EMITTED BY A MOVING SOURCE. W.G.V.Rosser.
Nature (GB), Vol. 190, 249 (April 15, 1961).
A proposal to test the ballistic theory of light propagation through a measurement of the velocity of γ-rays produced by in-flight decays of π^0-mesons. T.Erber

11698 REMARKS ON LORENTZ CONTRACTION. G.Gamow.
Proc. Nat. Acad. Sci. (USA), Vol. 47, No. 5, 728-9 (May, 1961).
Recent papers by Penrose and Weisskopf (Abstr. 9178 of 1959; 18915 of 1960) have dealt with the impossibility of seeing or photographing the Lorentz contraction of moving bodies. Here it is shown by examples that this is only so for particular cases of motion, and special methods of observation. C.W.Kilmister

11699 SUPPLEMENTAL VIEWPOINTS OF THE RELATIVISTIC LENGTH CONTRACTION AND TIME DILATION HELPFUL TO THE TEACHING OF INTRODUCTORY SPECIAL RELATIVITY. R.H.Chow.
Amer. J. Phys., Vol. 29, No. 9, 634-5 (Sept., 1961).
An important pedagogic point is made: in most elementary treatments the symmetry of the time dilation is stressed by showing how one observer deduces it from one transformation equation and the other from its inverse. It is desirable to show that each can deduce it from each equation. C.W.Kilmister

11700 ELECTROMAGNETIC SOURCES IN GENERAL RELATIVITY THEORY. T.R.Waite.
Phys. Rev. (USA), Vol. 123, No. 5, 1888-91 (Sept. 1, 1961).
The simplest, most direct method of unifying Maxwell's theory of electromagnetism and Einstein's theory of gravitation was formulated by Rainich in 1925. That theory applies only to charge-free space. However, in regions of space in which the electromagnetic field invariant corresponding to $\vec{E}.\vec{B}$ vanishes, the two sets of Maxwell's equations are independent for Rainich's unified theory. The Rainich theory may be modified to allow for non-vanishing charge and current density in such regions. The electromagnetic sources and fields obey Maxwell—Lorentz theory and the electromagnetic matter-energy obeys the laws of Einstein's general relativity theory. The necessary and sufficient conditions which one must impose on the metric tensor and its derivatives in order to assure the existence of a unique antisymmetric tensor obeying the Maxwell—Lorentz laws in the presence of charges and currents are derived.

11701 UNIFIED GRAVITATIONAL AND ELECTROMAGNETIC WAVES. P.C.Vaidya.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 305-14 (March, 1961).
Starting with a very general form of the nonsymmetric tensor g_{ik} expressed in a coordinate system suitably chosen to obtain wave solutions, a scheme is developed to derive rigorous solutions of the field equations of Einstein which describe the flow of unified gravitational and electromagnetic radiation. Several such solutions are derived giving waves with two dimensional symmetry. It is found that solutions describing gravitational and electromagnetic waves, obtained in the general theory of relativity with the help of an energy momentum tensor, can be derived in exactly the same form from the geometrical theory of the unified law of inertia enunciated by Hlavaty (1957).

11702 SOME REAL POSSIBILITIES TO EXTEND CLASSIC AND RELATIVISTIC CONSIDERATIONS UPON THE STUDY OF DIFFERENT PROCESSES OF MICROCOSM AND CONSTITUTING A PLAUSIBLE FUNDAMENT FOR VARIOUS UNIFIED FIELD THEORIES (A SYNTHETIC VIEW). T.T.Vescan.
An. Stiint. Univ. "Al. I. Cuza" Iasi (Ser. noua) I (Roumania), Vol. 6, Pt I, 101-28 (1960).

Sets out the point of view of the school, led by the author, whose aims include "the unification of quantum physics with general relativity". The novel methods are illustrated by a heuristic derivation of the Schwarzschild line element, an electrostatic description of nuclear forces, a discussion of the charge distribution on elementary particles according to Maxwell–Einstein theory, and other examples. F.A.E.Pirani

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

11703 QUESTIONS REGARDING THE FUNDAMENTALS OF FIELD THEORY. E.R.Caianello.
Nuovo Cimento. Suppl. (Italy), Vol. 10, No. 1, 61-6 (1960).
In Italian.

This article reports the content of a talk given by the author at the 45th Congress of the Italian Physical Society, held in Pavia from the 1st to the 7th October 1959. In this talk the author presented the essential features of a theory developed since 1953. The results obtained so far have been reported in a series of articles, which are quoted at the end of the paper. More than of a new theory, one should speak of a quite new approach to the description of physical processes in terms of a local field theory, with particular attention to the problem of the well-known divergences which occur in the present calculations of physical processes. Even though these divergences can be removed by a renormalisation procedure, it still remains unexplained whether their occurrence is intrinsically contained in a local field theory, or can be avoided with a more suitable mathematical formulation of such a theory. The latter is the point of view of the author, who asserts that his treatment of the field theoretical equations gives finite results at any stage of the calculation, for all the theories which are "consistent" with the mathematical procedure used. (In this way the concept of "consistency" replaces the old concept of "renormalisability" of a theory). Remarkable features of this treatment are the introduction of new mathematical quantities (namely pfaffians and hafnians) for describing fermion and boson fields; and the introduction of a new definition of the concept of integral, by using the Hadamard's "finite part" of an integral in place of the integral itself. The presentation of the theory in this paper is necessarily sketchy and free from formulae: if the reader is interested in the details of the mathematical formulation, he should rather refer to the papers quoted. Due to the complexity of the subject, the derivation of practical methods for calculating the quantities of physical interest is still to be achieved: the author himself presents his work up to date as a "starting point" rather than a "conclusion". Mathematical Reviews (E.Ferrari)

11704 SPECTRAL INTEGRAL FOR THE REPRESENTATION OF THE SPACE–TIME TRANSLATION GROUP IN RELATIVISTIC QUANTUM THEORY. A.Uhlmann.
Ann. Phys. (USA), Vol. 13, No. 3, 453-62 (June, 1961).

The structure of the representation of the space–time translation group in relativistic quantum theory is examined by means of an operator spectral integral. There is one and only one operator-valued function on the complex forward cone which is an analytic continuation of that representation.

11705 HYPERVIRIAL THEOREMS FOR VARIATIONAL WAVE FUNCTIONS. S.T.Epstein and J.O.Hirschfelder.
Phys. Rev. (USA), Vol. 123, No. 4, 1495-1502 (Aug. 15, 1961).

It is shown that a sufficient condition for an optical energy variational wave-function ψ_0 to satisfy the hypervirial relation $(\psi_0,[H,W]\psi_0) = 0$ is for the trial function ψ to admit variations of the form $\partial\psi/\partial a = (i/\hbar)W\psi$. Here H is the Hamiltonian, W is a Hermitian operator, and a is a variational parameter. Explicit forms of such trial functions are exhibited for several W's. The case in which W generates a point transformation of the coordinates is discussed in detail. Conditions are given for the existence of simultaneous hypervirial theorems.

11706 EVOLUTION OF A QUASI-STATIONARY STATE. R.G.Winter.
Phys. Rev. (USA), Vol. 123, No. 4, 1503-7 (Aug. 15, 1961).

To elucidate the time development of quasi-stationary state a simple barrier penetration problem has been studied. Both approximate expressions and numerical results for some parameters were obtained for the decay rate. First, irregular oscillations occur for a short time. Second, the exponential reg follows. Third, further oscillations occur during which the dec rate dips to negative values, so that the probability of finding th undecayed system increases briefly at several times. Fourth a finally, the decay rate decreases like an inverse power of the ti

11707 ON A SCHRÖDINGER EQUATION FOR A RADIATIN ELECTRON. G.Valentini.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1280-3 (March 16, 1961).

The classical equation of motion for a radiating charge, including radiation reaction terms to the fourth order, is recas into Hamiltonian form using the method of Ostrogradsky. A formal quantization then leads to the corresponding Schrödinge equation. T.E

11708 COLLISIONS OF RELATIVISTIC PARTICLES. B.L.Robinson.
Amer. J. Phys., Vol. 29, No. 6, 369 (June, 1961).

An invariant method of calculating relativistic threshold energies is given. J.S.Do

STATISTICAL MECHANICS TRANSFER PROCESSES

DEDUCTIONS FROM A FORMAL STATISTICAL MECHANIC THEORY OF CHEMICAL KINETICS. See Abstr. 11616

11709 ON THE CANONICAL DISTRIBUTION IN QUANTUM STATISTICAL MECHANICS.
J.van der Linden and P.Mazur.
Physica (Netherlands), Vol. 27, No. 6, 609-28 (June, 1961).

It is shown how, within the framework of quantum statistica mechanics, the canonical ensemble representing a system in th contact with a heat bath, may be obtained from the microcanoni ensemble representing an energetically insulated system. Use made in the derivation, which is analogous to Khinchin's deriva for the classical case of the phase space representation of quan statistical mechanics (Wigner distribution functions).

11710 THE STATISTICAL THEORY OF IONIC SYSTEMS. I.R.Yukhnovs'kyĭ.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 167-76 (1959). In Ukrai

The author presents and discusses a compact way of repre ing the free energy throughout a neutral system of ions. The bi and ternary distribution functions of this system are considered method for functional differentiation is also described, leading Coulomb distribution functions (without short-range forces).

11711 SELF-CONSISTENT PAIR INTERACTION FOR MA FERMION SYSTEM. K.Sawada and T.Soda.
Phys. Rev. (USA), Vol. 123, No. 4, 1087-99 (Aug. 15, 1961).

The equations which determine the one-particle energy and effective two-body interaction in an interacting Fermi gas are constructed within the approximation which sums up all pair creation–annihilation processes. The equation corresponds to familiar equation for the K matrix which represents the interac between particles (or holes) and sums up the particle–particle (or hole–hole) scattering processes. The method of the equatio of motion is used in this paper. The result for the one-particle e is shown to lead to the result previously obtained by Quinn and Ferrell (Abstr. 6244 of 1959) and by Rockmore (Abstr. 10260 of 1959) for the case of the electron gas with Coulomb interaction when screened potentials are replaced by bare potential in the self-consistent energy equation. For nuclear matter, it is show that the presence of an attractive interaction in the equation of motion for number density causes an "enhancement" of exchang forces, whereas in the electron gas repulsive Coulomb interact lead to "screening" of the exchange force. The strength of the isospin density interaction pseudopotential is enhanced by a fac of two when one solves the self-consistent equation; and a simp

nate shows that the Goldhaber-Teller mode lies about 15%
er than the value $p_F q/m$ previously estimated by Glassgold
. (Abstr. 4970 of 1959) (q: momentum of the oscillation, p_F:
ni momentum).

1712 ENERGY LOSSES IN A MANY-BODY SYSTEM. S.Engelsberg.
. Rev. (USA), Vol. 123, No. 4, 1130-7 (Aug. 15, 1961).
The energy loss problem is formulated in such a way as to
de all losses simultaneously. The lifetime and energy losses
particle in a well-defined single-particle state with small
sition probability are found to be related to the self-energy
ator. As an illustration of the application of the relation
ined, a derivation of the Bethe sum rule and the Cherenkov
es is given for a particle incident on a many-body system.

1713 EFFECT OF PERIODIC ADIABATIC TIME VARIATIONS ON INTERACTING SYSTEMS. H.Suhl.
. Rev. (USA), Vol. 123, No. 4, 1262-4 (Aug. 15, 1961).
It is shown that a many-particle system subject to periodic
batic variation of certain of its parameters is to a certain
nt equivalent to a non-time-varying system with a radically
ified interaction between the particles. The particular case of
lectron gas in a metal is discussed in some detail.

1714 COLLECTIVE REPRESENTATION OF THE MANY-PARTICLE SYSTEM INTERACTING THROUGH ITRARY TWO-BODY POTENTIAL. N.Shohno.
r. theor. Phys. (Japan), Vol. 24, No. 5, 991-1012 (Nov., 1960).
The collective description is given both in terms of the second
tized form and in terms of an auxiliary field analogous to the
tudinal electromagnetic field. As Bohm–Pines theory (Abstr.
of 1952; 1278 of 1954) of the collective description has some
tisfactory features concerning the subsidiary imposed on the
liary field, the author proposes a strict method of treatment
e subsidiary condition. To obtain a useful result for the
ctive representation, one has to take the three steps of the
nical transformations. Though the first two transformation are
ame as those of Bohm and Pines, the third transformation,
h is not applied by them and is characteristic of this theory, is
ssary for obtaining a meaningful result. By using both the strict
idiary condition and the three canonical transformation, the
ctive field coordinate and the particle coordinate are separated
nly in the total Hamiltonian bit also in the subsidiary condition.
over, the author is able to clarify the correct meaning of the
idiary condition and also the connection between this theory and
heory of Sawada, Brueckner, Fukuda and Brout (Abstr. 399 of
).

1715 APPLICATIONS OF MELLIN TRANSFORMS TO SOME PROBLEMS OF STATISTICAL MECHANICS.
ata.
r. theor. Phys. (Japan), Vol. 24, No. 5, 1118-22 (Nov., 1960).
Use of Mellin transforms is made to get an asymptotic form
integral containing a power series, where the term-by-term
gration cannot be allowed. Applications are given to problems
atistical mechanics, for example, the partition function of an
tron gas, the correlation energy of a free electron gas, and the
tion function of a hard-sphere gas at zero-temperature limit.

THE VARIATIONAL METHOD FOR THE CALCULATION OF TRANSPORT PARAMETERS OF ELECTRON CONDUCTORS.
Abstr. 11174

1716 AN APPROXIMATE SOLUTION OF FICK'S DIFFUSION EQUATION. T.Tsang.
pl. Phys. (USA), Vol. 32, No. 8, 1518-20 (Aug., 1961).
An approximate method of solving Fick's diffusion equation
he heat conduction equation) with variable diffusion coefficients
scussed. Simple solutions may be obtained. In one example,
esult appears to be in good agreement with the more elaborate
erical calculations by Crank (1959).

GENERAL MECHANICS

11717 PRESENTATION OF NEWTONIAN MECHANICS. N.Austern.
Amer. J. Phys., Vol. 29, No. 9, 617-22 (Sept., 1961).
Classical mechanics is sketched in elementary terms, from a sophisticated point of view. It is stressed that no formulation of the laws of motion constitutes a complete theory, susceptible of being compared with experiment. Instead, what these laws do is to show how to formulate theories of particular motions, by the introduction of (additional) laws of force. Because the basic force laws are simple in a suitable coordinate system, the over-all theory is simple, and useful, and is believed. The presentation given is designed for pedagogic use.

11718 NEW FIELDS OF APPLICATION FOR THE MOIRÉ METHOD. H.W.Loof and G.A.F.van der Sande.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 20-3.
Ligtenberg's moire-method is primarily a method for studying the moment distribution in slabs. As such it has amply proved its worth. New possibilities arise when the "slab analogies" are used, which exist for several problems in other fields of applied mechanics. Two such analogies are described. The first is concerned with thermal stresses in disks. The stresses correspond to moments in a slab, if there is a certain relation between the heat sources for the disk and the loading of the slab. In the second part the possibility of approximate analogies for shells is discussed. In a number of cases the description of a shell as a slab on elastic foundations is adequate. This analogy is realized experimentally by the use of a slab model floating on mercury.

11719 AN EXAMPLE OF STRESS ANALYSIS WITHOUT STRAIN MEASUREMENTS. F.K.Ligtenberg.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 33-7.
Investigations were carried out on the strength of the welded connection between a beam and a column. It is not sufficient to know that a certain connection has a certain strength, it is necessary also to know why it has that strength. This is impossible without knowing which part of the total load was transmitted by each of the individual welds. (In all there were five different welds under different loading conditions.) Measurements of the deformations of the welds would not give much indication of the magnitude of the force that was transmitted, because only data on the strength of welds under different loading conditions were available. Only the breaking strength of the whole connection could be measured therefore. Theoretical analysis, combined with a very systematic arrangement of the test series and inclusion of a number of special tests for purposes of interpretation made it possible nevertheless to find out which forces were transmitted by each individual weld at the moment of rupture. It appears that the most rigid of the welds (loaded in pure tension) is comparable in rigidity with the most ductile part of the I-beam (flange loaded with shearing force). Between the welds under different loading conditions very great differences in rigidity were observed. It is therefore not allowable to sum the total strength of all the individual welds to obtain the total strength of the whole connection.

11720 QUANTITATIVE DETERMINATION OF THE DYNAMIC STRESS CONDITIONS IN TRANSVERSELY IMPACTED BENT BEAMS WITH THE AID OF SPARK CINEMATOGRAPHY AND [PHOTOELASTIC] STRESS OPTICS.
H.H.Emschermann, R.Flossmann and K.H.Rühl.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 38-44. In German.
The shear stress and shear force distributions are determined in plain and notched beams impacted transversely at the centre by a falling mass. A polariscope with spark illumination supplies six photographs at time intervals adjustable between 10^{-3} and 2.5×10^{-5} sec by means of a variable delay unit. Without this unit, the interval between consecutive pictures can be shortened to 10^{-7} sec by adjustment of the coupling elements. From several series of consecutive pictures of fringes and isoclines the shear stress distributions can be determined quantitatively. In addition, the strains at the bottom edge of the beam are measured by wire resistance strain gauges. The fringe pictures and local stress distributions give a clear understanding of the phenomena in the impacted beams during the first 200 μsec.

11721 BENDING STRESSES IN A SHAFT WITH A TRANSVERSE HOLE. H.Fessler and E.A.Roberts.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 45-9.

The frozen stress photoelastic technique was employed and the exact positions and magnitudes of the greatest stresses were determined by successive rubbing down of the relevant slices. The shaft was a model of a cantilever-type rotating bending fatigue specimen which contained a small transverse hole. The ratio of hole diameter to shaft diameter was 1/6. The model was arranged with its axis vertical to eliminate bending stresses due to its own weight (these are negligible in the fatigue specimen) and the upper part was counterbalanced to eliminate compressive stresses due to its own weight near the transverse hole. The load was determined from the bending stresses remote from the hole. Curing stresses and variation of material fringe value along the length of the specimen were investigated and suitable corrections made. Results are given for: (1) the hoop stresses around the hole near the most highly stressed section, (2) one plot of the "rubbing down" process, (3) hoop stresses at the hole plotted across the shaft, (4) the axial stresses in the surface of the shaft, and (5) the deflected shape of the hole. The greatest stresses occur at the surface of the hole 0.07 shaft radii from the edge of the hole. This confirms and augments the extensometer results of Thum and Kirmser.

11722 CONTRIBUTION TO THE PHOTOELASTIC INVESTIGATION OF SHELLS. G.Franz and W.Teepe.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 50-7. In German.

A method is developed for the photoelastic investigation of shells; the equipment and model materials are described. The authors show that for small relative retardations the measured phase lag corresponds to the difference of the principal stresses for the membrane state of stress. The membrane and the bending states of stress are separated by a second measurement in which a thin and photoelastically very sensitive layer with mirror backing is deposited on the surface of the shell and observed in a reflection polariscope. Two examples show the application of the method.

11723 SOME NEW [PHOTOELASTIC] STRESS-OPTICAL METHODS. A.Kuske.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 58-65. In German.

A method has been developed for determining optical phenomena in polarized light when the directions of principal stress are not constant along the path of the light beam. This method allows the stresses in certain three-dimensional problems such as shells (where the membrane and bending stresses have different directions) to be analysed with a normal model. Moreover, it can be applied to determine the stresses in laminated three-dimensional models and it is very helpful in the determination of the stresses in the frozen-stress and scattered-light methods. The method can be used to solve some old problems in a much easier or more exact way, such as the building-up of an accurate quarterwave plate from two or more inaccurate ones, or the stresses in a bent plate by Drucker's method. In two- and three-dimensional photoelasticity the lines of constant shear stress can be determined experimentally without additional calculation. Thus, the computation of the normal stresses by integration can be accomplished with greater accuracy.

11724 USE OF THE PHOTOELASTIC METHOD FOR THE STUDY OF RESIDUAL STRESSES. C.F.Moretti.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 66-70. In French.

The aim of this study is to show that an analogy method such as photoelasticity can be used for the determination of residual stresses. When stresses are created by an isotropic dilation of an element and follow a diffusion phenomenon, mathematical analysis shows that it is possible to develop an analogy method. It can, in fact be shown that two geometrically similar specimens of different material but characterised by the same dimensionless parameter depending on the diffusion considered, will have the same isostatics. Residual expansion stresses were developed by diffusing molecules of water into photoelastic materials. The stresses developed in this way obey the equations previously established. The birefringence which accompanies this diffusion is thus physically significant and permits determination of the distribution of residual stresses in the specimen.

11725 METHOD FOR THE PHOTOELASTIC MEASUREMEN OF STRESSES "IN EQUILIBRIUM IN THE THICKNES OF A PLATE. (PARTICULAR CASES OF TOUGHENED GLASS AD BENT GLASS). P.Acloque and C.Guillemet.
Institute of Physics Stress Analysis Group Conference, Delft, 19 (see Abstr. 10455 of 1961) p. 71-6.

Under the effect of thermal or chemical treatment, a strain-system is able to develop in plates of photoelastic material in su a way that the strains lie in planes parallel to the faces and are mechanically balanced through the thickness with, for example, compression in the outer layers and tension in the inner layers. similar system exists also in a plate under flexure. The authors observed that when the light path is inclined at a low angle to the layers, it is possible to have a measurable birefringence, notwitl standing the symmetry and balance of the strains along the light path. Calculations show that at such an inclination the ordinary a extraordinary rays are curved by a mirage effect, thus issuing w some measurable lag. This lag depends on the state of stress by means of both photoelastic constants, direct and transverse, of t material. The method is convenient for toughened glass, but can also be used with other kinds of stratified strains, such as bendi strains for instance.

11726 STRESS ANALYSIS ON THREE-DIMENSIONAL MODE N.I.Prigorovsky.
Institute of Physics Stress Analysis Group Conference, Delft, 195 (see Abstr. 10455 of 1961) p. 77-82.

The stress distribution and displacements in actual compone and joints are analysed with three-dimensional plastics models. Models for strain measurements, made of materials with a low Young's modulus, simplify the analysis of complex elements and assemblies. For compound constructions the conditions of assem ly and rigidity of the joints are reproduced satisfactorily. The photoelastic materials used for this analysis meet all requiremen The conditions of structural similarity are better fulfilled when t models are loaded at room temperature. Scattered light is used this case. Equipment, experimental techniques and methods of solution for typical problems have been specially developed. Roo temperature photoelastic analysis is easily performed on models made of optically insensitive material "ONS" with cemented-in plates of "ED6-M". In oblique light on the edges of these plates, the stresses on their outlines are determined by means of the frin gradient. Every type of three-dimensional model and method of measurement has its own preferred field of application. For com pound joints the models for strain measurement are used to find t general distribution of stresses, loads and displacements whilst photoelastic models are used to find the stress concentrations.

11727 A METHOD OF SEQUENCE OF NETWORKS IN PROBLEMS OF ELASTICITY. J.Szmelter.
Arch. Mech. stos. (Poland), Vol. 12, 357-70 (1960).

An interesting practical method is described for finding the numerical solution of boundary value problems of classical elas-ticity. The method of sequence of network depends on finite diffe ences and can readily be used on high speed computers. The rapi convergence of the method is illustrated by four numerical examp les. The method can successfully be adopted for solving other physical problems. Mathematical Reviews (B.R.Set

11728 STRESS AND STRAIN IN THIN FILMS BULGED OVER CIRCULAR OPENINGS. R.Papirno.
J. appl. Phys. (USA), Vol. 32, No. 6, 1175-6 (June, 1961).

The usual assumptions that the bulge surface is a spherical cap and that strain is uniform over the surface of the cap leads to simple expressions for stress and strain which do not fit data measured by strain gauges. An improved expression for the central radius of cap is obtained and the stress equation is fitted the measured data; this differs significantly from the theoretical relation based on the usual assumptions. J.K.Skwirzynsk

11729 CALCULATION OF THE BEHAVIOUR OF RUBBER-COVERED PRESSURE ROLLERS. G.J.Parish.
Brit. J. appl. Phys., Vol. 12, No. 7, 333-6 (July, 1961).

Data are given which enable the properties of nips between metal and rubber-covered pressure rollers to be calculated from the parameters of the system. The properties with which the calculation is primarily concerned are the nip width and the mean pressure in the nip, but the principle can be extended to include the peak pressure and the distribution of pressure through the nip The calculation is based on the well-known Hertzian formula and

mpirical relations, which express the important effects of ubber-cover thickness. The data refer not only to roller ms in which the loading is uniform, but also to non-uniform in particular to those which show what is probably the nonest cause of non-uniformity, roller deflection. Although alculations refer primarily to nips between one hard roller ne relatively soft, covered, roller, they are directly applicable ps between two indentical covered rollers and may be applied, n limits, to systems in which the rollers are dissimilar in erties.

11730 SOME COMMENTS ON THE INTEGRATION OF ROTATION ABOUT THE CENTRE OF GRAVITY IN A JLATOR. F.H.Raymond.
Assoc. Internat. Calcul Analogique (Belgium), Vol. 2, No. 4, 9 (Oct., 1960). In French.
The author considers how the kinematic equations governing the t path of a body, and the rotation of that body about its centre of ity, can be represented in a flight simulator. The attitude of the ing body is conveniently defined with respect to fixed earth axes set of three Euler angles. This system leads to a singularity e solution of the kinematic equations, and to overcome this it is ified by the introduction of a fourth angle into the set of Euler es. H.Morrison

11731 CONVENIENT EQUATIONS FOR PROJECTILE MOTION. J.G.Winans.
r. J. Phys., Vol. 29, No. 9, 623-6 (Sept., 1961).
Quaternion multiplication of the basic vector for uniformly lerated motion gives two equations, $v^2 = u^2 + 2\vec{a}\cdot\vec{s}$ and $\vec{s} = \vec{v} \times \vec{u}$, which provide a simple solution for some projectile blems. For a given s and a, the two times of flight are described $t_2 = 2s/a$.

MECHANICAL MEASUREMENTS

11732 THE MEASUREMENT OF SMALL DISPLACEMENTS BY ELECTRICAL SCREENING. B.E.Noltingk.
itute of Physics Stress Analysis Group Conference, Delft, 1959, e Abstr. 10455 of 1961). p. 83-7.
A conducting screen interposed between two coils affects their ctrical coupling. It is shown how the dependence of this effect he exact position of the screen can be made the basis of a nsducer converting mechanical displacements to electrical nals. Such a system needs only a small element attached to the ving part to be measured; it is insensitive to movements in ections other than those studied; and it can allow an indefinite rtravel of the moving element. A small instrument is described, ed on this principle, which has a linear range of 10 mm and a o stability of a fraction of a micron, allowing displacements to be erved on any scale between millimetres and hundreds of Ang-om units.

11733 MISLEADING ACCELEROMETERS. J.C.Tukker and J.H.Janssen.
stica (Internat.), Vol. 10, No. 3, 186 (1960).
Inconsistent results obtained in sound radiation and noise asurements in structures using piezoelectric accelerometers e traced to differences in the output of the accelerometers when r orientation was changed. Differences of more than 20 dB were erved both in the output of a particular piezoelectric pick-up and he average outputs of two pick-ups when they were used for asuring the acceleration level of a thin vibrating steel plate. erences of 5 dB were observed in similar experiments on a crete floor. A bending type of crystal accelerometer was found e insensitive to rotation of the piezoelectric element. H.J.H.Starks

11734 PRECISION DYNAMOMETRY. G.Fouretier.
itute of Physics Stress Analysis Group Conference, Delft, 9 (see Abstr. 10455 of 1961) p. 92-8. In French.
The spring element of a mechanical dynamometer may have an uracy well within 0.1% error. Strain gauges are a convenient ns of measuring the deformation of the spring element but in strial practice a precision of the order of 0.1% is only obtained painstaking precautions. After an analysis of the shortcomings of strain gauges, the author describes single improvements (e.g. anchorages) and also the overall improvement in the use of the instrument, which has led to the design of "electronic load cells", confirmed by the French Weights and Measures Department as having a precision better than 0.1% error.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

11735 DEVELOPMENT TENDENCIES IN VISCOMETRY. W.Meskat.
Arch. tech. Messen (Germany), No. 304 (Ref. V91200-F1), 115-18 (May, 1961). In German.
Viscometry is here considered from the point of view that some materials obey the Navier—Stokes equations, whereas the majority of liquids do not. Reference is made to automatic recording viscometers. R.Schnurmann

11736 HYDRODYNAMIC RESEARCH. F.S.Burt.
Brit. J. appl. Phys., Vol. 12, No. 7, 328-8 (July, 1961).
A brief survey is given of some hydrodynamic research problems of particular interest to naval and marine applications. A description is given of model ship towing tanks and their use in studying resistance and propulsion problems of ships. The use of special sea-keeping and manoeuvring basins from model ship studies of sea-keeping and manoeuvring characteristics is mentioned. Another topic is the study of ship propulsion research and a description is given of cavitation tunnels and their use in this connection. Some detail is given of the particular sphere of underwater hydrodynamic research and the special facilities and instrumentation which have been developed at the Admiralty Research Laboratory for research into this specialized field including the use of slotted wall working sections in water tunnels and the large rotating beam channel. The unusual hydrodynamic research problems associated with the entry of missiles from the air into the water are briefly surveyed as are those of two-phase flows in gas liquid mixtures. The paper concludes with a brief mention of possible high performance vessels of the future including hydrofoil craft, hovercraft and underwater cargo vessels.

11737 FOUNDATIONS OF LINEAR VISCOELASTICITY. B.D.Coleman and W.Noll.
Rev. mod. Phys. (USA), Vol. 33, No. 2, 239-49 (April, 1961).
The fundamental hypotheses of linear viscoelasticity are re-examined, and a new theory is formulated, based on the earlier work of the authors and incorporating the idea that the dependence of the stress on the history of the deformation is a smooth dependence. A second-order theory of viscoelasticity for incompressible simple fluids is also discussed. K.Walters

11738 NOTE ON THE MECHANICAL ANALOGY OF A VISCOELASTIC FLUID. P.G.Morgan.
Brit. J. appl. Phys., Vol. 12, No. 7, 348 (July, 1961).

11739 UNIFIED RHEOLOGICAL RELATION OF NON-NEWTONIAN FLUIDS. C.C.Chang and P.Ramanaiah.
Phys. of Fluids (USA), Vol. 4, No. 9, 1179-81 (Sept., 1961).
A new phenomenological formulation of a unified rheological relation of non-Newtonian fluids is described. This relation checks very closely for many non-Newtonian fluids. As a first approximation, a power law of velocity gradient representing viscosity is also derived for the intermediate range between the upper and lower limits of viscosity.

11740 KELVIN—HELMHOLTZ INSTABILITY IN MEDIA OF VARIABLE DENSITY. Z.Alterman.
Phys. of Fluids (USA), Vol. 4, No. 9, 1177-9 (Sept., 1961).
The instability of two fluids separated by a horizontal boundary and in relative horizontal motion is investigated in the case of densities varying exponentially with height. There is a striking similarity between the effects of density variation and of rotation on the onset of instability. Conditions for stability are given, and the effect of a superposed magnetic field is discussed.

TRANSIENT MAGNETOHYDRODYNAMIC DUCT FLOW.
See Abstr. 12008

AXISYMMETRIC PERTURBATIONS IN A CONDUCTING LIQUID CONFINED BY RIGID WALLS. See Abstr. 12011

11741 TRANSVERSE OSCILLATIONS OF A LIQUID JET. II. J.B.Brackenridge and W.L.Nyborg.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1078-84 (Aug., 1961).

For Pt I see Abstr. 16681 of 1960. A thin rectangular liquid jet impinges on the apex of a rigid wedge and, under suitable circumstances, sets itself into any of a number of modes or "stages" of steady-state transverse oscillation; any mode has associated with it a pattern of vortex production. Excerpts from motion pictures show sequences of jet configurations corresponding to the different modes of oscillation. In a photographic history depicting the buildings of oscillations in an initially quiescent jet, particular interest is attached to the fact that oscillations appear before vortices have developed. Observations from these photographs and results from an earlier paper are compared with predictions of recent theories of edge tone production.

11742 CAPILLARY INSTABILITY OF A LIQUID JET. Z.Alterman.
Phys. of Fluids (USA), Vol. 4, No. 8, 955-62 (Aug., 1961).

The capillary instability of a liquid cylindrical jet is studied both in the case of a static jet or a jet in pure axial motion, with additional rotation and with a superposed magnetic field. The static jet, which is unstable for axisymmetric perturbations of wavelengths exceeding its circumference, is stabilized by a sufficiently strong magnetic field. Rotation causes stability or instability according to the relative angular velocities of jet and surroundings. A jet in axial motion is unstable even in a magnetic field. For a given velocity, the jet is stable only for such perturbations which have wave numbers exceeding a given value.

11743 EXPANSION AND CONTRACTION OF CAPILLARY JETS OF VISCOELASTIC LIQUIDS.
S.Middleman and J.Gavis.
Phys. of Fluids (USA), Vol. 4, No. 8, 963-9 (Aug., 1961).

The increase of diameter, or expansion which occurs when viscoelastic liquids are ejected into air from a capillary nozzle is investigated. For low ejection velocities the jet expands; the expansion reaches a maximum with increasing velocity then decreases; at high velocity the jet contracts. An analysis based upon the momentum equation for the jet shows the phenomenon to be dependent upon the Weber number, the rheological properties of the fluid, and the ratio of the tension in the jet to twice the kinetic energy of ejection. The origin of the tension is thought to lie in three different effects: a non-linear normal stress developed in the capillary, a viscous normal stress developed outside the capillary as a result of relaxation of the original velocity profile in the capillary, and a normal stress developed outside the capillary as a result of elastic reaction to profile relaxation.

11744 SIZE DISTRIBUTION DETERMINATIONS OF NON-VOLATILE DROPLETS BY LIGHT AND ELECTRON MICROSCOPY. W.J.Harris.
Brit. J. appl. Phys., Vol. 12, No. 7, 348-9 (July, 1961).

11745 EXPERIMENTAL RESULTS RELATING TO THE COALESCENCE OF WATER DROPS WITH WATER SURFACES. R.M.Schotland.
Disc. Faraday Soc. (GB), No. 30, 72-7 (1960).

An experimental study was made of parameters which control the coalescence of drops in the diameter range 200 to 800 microns with large liquid hemispherical targets. It is shown that the initiation of the coalescence mechanism for electrically neutral drops in equilibrium with their vapour is governed by two dimensionless parameters:

$$\pi_1 = \rho_D V_N^2 D/\gamma,\ \pi_2 = \rho_M/\rho_D,$$

where ρD = drop density, ρM = medium density, γ = surface tension, V_N = normal component of impact velocity and D = drop diameter.

11746 THE GROWTH OF HYGROSCOPIC DROPS IN A HUMID AIR STREAM. W.L.Dennis.
Disc. Faraday Soc. (GB), No. 30, 78-85 (1960).

The growth rate of drops is of importance in considering the possibility of dissipating natural fog by spraying solutions of hygroscopic substances. The effect of relative humidity and ambient air speed upon the rate of growth of drops of sulphuric acid, calcium chloride, sodium chloride and ammonium nitrate solutions was investigated for drops in the approximate size range 0.5 to 1.0 m It was found that the rate can be deduced from a combination of v known equations, in terms of the diffusion of vapour from the dr the heat balance and a ventilation factor.

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

11747 RAYLEIGH SCATTERING OF LIGHT AND ORIENTATIONAL ORDERING OF MOLECULES.
M.I.Shakhparonov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 5, 1162-4 (Feb. 9, 1961). In Russian.

Derives an expression for the intensity of light scattered by system of molecules, including terms representing correlations between the directions of the principal axes of the polarizability ellipsoids. When used in conjunction with experimental results, the expression can be used to estimate the degree of orientationa order in homogeneous isotropic molecular systems. The absence of orientational order in acetone, nitrobenzene, chlorobenzene, bromobenzene, chloroform and ether, appears to be confirmed.
S.Cho

11748 X-RAY INVESTIGATION OF COPPER ACETATE SOLUTIONS IN WATER.
I.M.Shapovalov and I.V.Radchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 815-19 (1958). In Ukrain

A study was made of water and aqueous solutions of copper acetate with concentrations of 2.2, 3.4 and 6.4 per cent, at 20°C. The intensity curves of the solutions were found to differ little fr those of water. The position of the first maximum on the radial distribution curves is 2.85 A both for water and for the solutions, but the area under these maxima decreases with an increase in th concentration of the solution. On the grounds of an analysis of th distribution curves, the inference is made that $CuAc^+$ ions exist i the investigated solutions of copper acetate, and that these ions m contribute to the simultaneous formation of two structures in wat a loosely-packed structure with a less intense translation motion molecules and a denser structure with an intensified translation motion.

SELF-DIFFUSION AND THE STRUCTURE OF MOLTEN SALTS. See Abstr. 11755

11749 [CONTRIBUTION] TO THE PROBLEM OF THE STRUCTURE OF LIQUID WATER. G.G.Malenkov.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 6, 1354-5 (April 21, 1961). In Russian.

According to the author's model neighbouring molecules are linked by hydrogen bonds in a near-tetrahedral arrangement. It is assumed that most of these bonds stand perpendicular on a plan of symmetry whereas bonds of central symmetry are present in small numbers only. The density and radial distribution correspo ing to that model are compared with empirical data; agreement c be achieved by minor adjustments of the model. [English translat in: Soviet Physics – Doklady (USA)]. R.Eisenschi

11750 ENERGY AND FREE ENERGY OF COHESION. B.Linder.
J. chem. Phys. (USA), Vol. 35, No. 1, 371-2 (July, 1961).

The difference between these two concepts is emphasized; while the total interaction potential (as calculated in Abstr. 16687 1960) is a free energy, the correct quantity to be compared with t energy of vaporization is the energy of cohesion. This is comput for four nonpolar liquids, and agrees better with energy of vapori tion than does the total interaction potential. J.Hawg

11751 FORMULATION OF A CELL MODEL USING PERIOD BOUNDARY CONDITIONS.
D.R.Squire and Z.W.Salsburg.
J. chem. Phys. (USA), Vol. 35, No. 2, 486-92 (Aug., 1961).

A cell-type model for the liquid state, based upon the conside ation of small systems with periodic boundary conditions, is introduced. The equation of state for rigid-sphere molecules is then calculated for a tetragonal cell. By property choosing the dimensions of the tetragonal cell, the equation of state for a

m of rigid spheres which form a face-centred cubic lattice in regular lattice configuration is obtained. The model yields orrect second virial coefficient. The results are compared the Monte Carlo calculations of Wood and Parker, the "averaged l" results of Buehler et al., and the Lennard-Jones and nshire theory.

752 SOLUTIONS TO THE PERCUS–YEVICK EQUATION. A.A.Broyles.
em. Phys. (USA), Vol. 35, No. 2, 493-6 (Aug., 1961).
The radial distribution function for a classical fluid of particles acting with the Lennard-Jones potential has been computed lving the Percus–Yevick (Abstr. 2817 of 1958) integral ion numerically. The solutions and the quantities, p/nkT and T, are compared with those obtained by Wood and Parker ; Monte Carlo techniques. The radial distribution functions e to better than 15% beyond the first points where they are while the thermodynamic quantities differ by, at most, 3% the range of Monte Carlo values for cases where the system lieved to be in a liquid state. The quantity

$$K = -(1/V)(\partial V/\partial p)_{N,T},$$

mputed.

1753 THE CAGE MODEL BY NON-SPHERICAL INTERACTION POTENTIAL. T.Nagata.
amoto J. Sci. A (Japan), Vol. 3, No. 2, 115-23 (Feb., 1957).
The interaction considered is that between spheroidal molecules l by Rowlinson and Sutton (Abstr. 4418 of 1955). An approximate hod of averaging over the angles is introduced and correcting ns to Lennard-Jones and Devonshire's expressions (Abstr. 3 of 1937; 1683 of 1938) for the free energy and pressure are ived. H.N.V.Temperley

1754 ATOMIC POLARIZATION. II. VIBRATIONAL POLARIZATION OF LIQUIDS. K.H.Illinger and C.P.Smyth.
chem. Phys. (USA), Vol. 35, No. 2, 392-6 (Aug., 1961).
For Pt I, see Abstr. 5904 of 1960. A theory applied specifically the problem of the vibrational polarization of liquids is presented, l a detailed discussion is given of the vibrational polarization ms in isotropic condensed states.

1755 SELF-DIFFUSION AND THE STRUCTURE OF MOLTEN SALTS. A.Lundén.
mers Tekn. Hogsk. Handl. (Sweden), No. 241, 14 pp. (1961).
The measured self-diffusion coefficients are of the same r of magnitude for all molten salts that have a high electric luctivity, and there is a pronounced tendency for the cation and n activation energies to be equal. The diffusion process seems e insensitive to the size and shape of the ions. An attempt to nd existing theories for the structure of liquids to include ten salts gives reasonable results in many cases. However the erved degree of consistency with experimental data is not such any particular model can be claimed to be superior to the others. re is a great need for further measurement.

1756 ANISOTROPY OF WATER CLUSTER ABOUT THE Cu^{++} ION. A.Mookherji and M.S.Chhonkar.
an J. Phys., Vol. 34, No. 3, 147-8 (March, 1960).
Measurements of the absorption spectra of the Cu^{++} ion in eous copper sulphate solution show the presence of two maxima. s is interpreted as evidence that the water cluster about the per ion has approximate tetragonal symmetry.
W.J.Orville-Thomas

1757 VISCOSITY AND CONDUCTIVITY OF ZINC AND CADMIUM AMALGAMS. O.Z.Golyk and I.F.Klassen.
ayin. fiz. Zh. (USSR), Vol. 3, No. 5, 683-7 (1958). In Ukrainian.
An earlier research studied the viscosity of these amalgams in temperature interval from 30° to 160°C and concentrations from 30 at.% [Ukrayin. fiz. Zh. (USSR), Vol. 1, 170 (1956)], as well as r structure (Abstr. 9031 of 1957). In the present investigation, authors extended the range of temperatures and concentrations also studied the conductivity. The results of the investigation given in 2 graphs and in 2 tables. The temperature dependence he viscosity is subject to an exponential law, the activation rgy of the viscous course being a linear function of the concentra- New isoviscous solutions were found:

(1) 20.8% Cd in Hg and 9.5% Zn in Hg,
(2) 25% Cd in Hg and 11.4% Zn in Hg,
(3) 30% Cd in Hg and 13.6% Zn in Hg.

SUMMARIZED PROCEEDINGS OF A CONFERENCE ON PHYSICS OF POLYMERS — BRISTOL, JANUARY, 1961.
See Abstr. 11587

11758 MEASUREMENT OF THE ACOUSTIC IMPEDANCE OF A VISCOELASTIC FLUID IN A CIRCULAR TUBE.
G.B.Thurston.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1091-5 (Aug., 1961).
The results of measurement of the acoustic impedance of some viscoelastic liquids in circular tubes are presented. The liquids studied include water, petroleum oil, glycerol, silicone fluid, milling yellow solution and agar solution, the last three showing elastic effects. One of these elastic effects is the changing of the acoustic reactance from the inertance type to the compliance type. Measured results are presented for frequencies from 3 c/s to 300 c/s and for tubes having radii in the range 0.0172 cm to 0.354 cm. Methods are presented for determination of the complex coefficient of shear viscosity from the acoustic impedance properties and examples are given.

11759 INVESTIGATION OF THE ULTRASONIC VELOCITY IN, AND COMPRESSIBILITY OF, CERTAIN NON-AQUEOUS SOLUTIONS OF ELECTROLYTES.
H.P.Roshchyna and E.D.Ishchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 268-71 (1959). In Ukrainian.
The influence was investigated of temperature and concentration on the ultrasonic velocity in, and adiabatic compressibility of, solutions of KI in glycol, glycerine and ethanol. In solutions of KI in glycol and glycerine, the velocity was found to decrease with an increase in electrolyte concentration; for KI in ethanol, the velocity is practically unchanged. Adiabatic compressibility decreases somewhat with an increase in electrolyte concentration for all investigated solutions, which is connected with the increase in density. An investigation was also made of the molecular scattering of light in these solutions. It is shown that in solutions of KI in glycol and glycerine considerable fluctuations of concentration develop within a definite range of concentrations, due to a rise in temperature. Adding KI to the given solvents results in a perceptible increase in the intensity of the anisotropic scattering of light, which is, apparently, connected both with the change in the short-range orientation order and with the change in the anisotropy of the solvent molecules themselves. In solutions of KI in ethanol, no perceptible fluctuations of concentration were noted. Several assumptions are advanced as to the possible causes of negative viscosity in the investigated solutions.

11760 ULTRASONIC STUDIES IN CHEMICALLY ACTIVE LIQUID MEDIA. I. AQUEOUS SOLUTION OF N_2O_4.
M.Krishnamurthi and M.Suryanarayana.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2318-23 (Dec., 1960).
Using a pulse method the ultrasonic absorption was studied in the frequency range of 2 to 10 Mc/s in dilute aqueous solutions of nitrogen tetroxide gas at room temperature. The absorption peaks ($\alpha\lambda$ versus frequency) observed in this study are attributed to the ionic dissociation reaction of the nitrous acid into its constituent ions. The rate constants of the forward and backward reactions are calculated using the theory of Tabuchi (Abstr. 8232 of 1957). The variation of the logarithm of the rate constant of the bimolecular ionic reaction, namely, $\log_{10} k_b$, with the square root of ionic strength qualitatively follows Bronsted's theory for ionic reactions in solutions.

ON THE PROPAGATION OF SOUND IN A LIQUID CONTAINING GAS BUBBLES. See Abstr. 11813

11761 STUDY OF AQUEOUS SOLUTION OF STRONG ELECTROLYTE — RE-EXAMINATION OF MOLECULAR REFRACTION. T.Satoh and K.Hayashi.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1658-63 (Sept., 1960).
The molecular refraction of a 1–1 electrolyte aqueous solution was re-examined in the light of a proposed model. So called Lorentz–Lorenz function was plotted against the molar fraction of the electrolyte. Linear relationships and critical phenomenon dividing the whole range into two were found. The total number of hydrations, $n_I^{(+)} + n_I^{(-)} + n_{II}^{(+)} + n_{II}^{(-)}$, are obtained where the hydration numbers around each cation and anion are defined as $n_I^{(+)}$, $n_I^{(-)}$ (referred to the primary region) and $n_{II}^{(+)}$, $n_{II}^{(-)}$ (referred to the secondary region), respectively. The polarizability α_* of water molecules which are considered as "solvent in the concentrated range" and subjected to the sufficient effect of polarization from surrounding ions is estimated.

11762 THE OPTICAL PROPERTIES OF LIQUID GERMANIUM, TIN AND LEAD. J.N.Hodgson.
Phil. Maq. (GB), Vol. 6, 509-15 (April, 1961).

The optical constants of liquid germanium, tin and lead were measured by a reflection method for wave-numbers between 4000 and 27 000 cm^{-1} (wavelengths 2.5 to 0.37 μ). The temperature variation of the optical constants was measured for tin and lead. The experimental results follow approximately the Drude free-electron formulae if the number of free electrons per atom, N_0, and their relaxation time, τ, are treated as adjustable parameters. The values of N_0 lie between 4.3 and 4.7, with a slight temperature variation. The values of the static conductivity calculated from N_0 and τ are compared with electrically measured values. Previous optical measurements on evaporated films of tin and lead have indicated values of N_0 between 1.2 and 1.4 for the solid metals.

11763 METHOD FOR DISTINGUISHING BETWEEN OVERLAPPING TRANSITIONS IN ELECTRONIC ABSORPTION SPECTRA WITH APPLICATION TO AZULENE.
W.W.Robertson and A.D.King, Jr.
J. chem. Phys. (USA), Vol. 34, No. 6, 2190-1 (June, 1961).

Such transitions may be distinguished by the effects of changes in molecular environment if they have different oscillator strengths, or, for polar absorbers, if the dipole moments of the excited states are not the same. The effects are briefly discussed in terms of different types of solute–solvent interaction, and it is shown that varying frequency shifts will result from changes in solvent properties and dielectric constant. Such changes may be brought about by changing the nature of the solvent, the temperature, the pressure, or by measurements in the gas phase. Least complications are expected for pressure changes. Such frequency shifts are illustrated as functions of solvent density for three different transitions of azulene. A further band, at 2956A, has a much smaller shift than the adjacent $1B_b$ band, confirming the assignment of the former (Abstr. 2506 of 1957) to a transition different from the latter.
J.Sheridan

11764 RAMAN SPECTRA AND IONIC INTERACTIONS IN MOLTEN NITRATES. G.J.Janz and D.W.James.
J. chem. Phys. (USA), Vol. 35, No. 2, 739-44 (Aug., 1961).

A simple experimental assembly designed for use with a conventional Toronto-type source and capable of use at temperatures up to 700°C is described for the Raman technique. Application to the series of molten inorganic salts Li, Na, K, Cs, Rb, and Ag/NO_3, and selected mixtures of these, is reported. The Raman frequencies, relative intensities, depolarization ratios, and vibrational force constants are discussed. A regular variation of the Raman frequencies and force constants which correlates with the change in the polarizing power of the cationic environment is noted. The results are examined in the light of current views on the structure of molten salts.

INFRARED SPECTRA OF NaOH ABOVE AND BELOW THE MELTING POINT. See Abstr. 11381

THE EFFECT OF THE REFRACTIVE INDEX OF A SUBSTANCE ON THE TEMPERATURE DEPENDENCE OF THE RAMAN BAND INTENSITIES. See Abstr. 11385

11765 QUENCHING OF PHOTOLUMINESCENCE OF SOLUTIONS. C.Bojarski.
Acta phys. Polon. (Poland), Vol. 19, No. 6, 631-6 (1960).

The accuracy of the model using the active sphere of Jablonski's theory (Abstr. 854 of 1955) of quenching of photoluminescence of solutions was improved by accounting for the effect of quencher molecules beyond the active sphere on an excited luminescent molecule, and for fluctuations in their concentration. The expression obtained for the relative yield is compared with experimental results of other authors.

11766 DETERMINATION OF THE DISTRIBUTION CURVE OF THE LENGTHS OF LINEAR MACROMOLECULES IN SOLUTION BY DIELECTRIC ABSORPTION.
E.Marchal and J.Marchal.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 82-8 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The absorption spectrum of poly DL phenylalanine of molecular weight 81 000 in chloroform is interpreted. A theoretical study of the dependence of dielectric absorption on the length of the polymer chain is found. The agreement between theory and experiment i good. T.E.Pea

11767 NUCLEAR MAGNETIC RESONANCE OF PROTON COMPLEXES OF WEAK BASES.
C.MacLean and E.L.Mackor.
J. chem. Phys. (USA), Vol. 34, No. 6, 2207-8 (June, 1961).

Well-defined spectra were obtained for the proton complexe of water, ethyl alcohol, and acetone when solutions in anhydrous hydrogen fluoride saturated with boron trifluoride were cooled do to about −75°C, so as to reduce the proton exchange rates.
E.F.W.Seyn

11768 THE NUCLEAR MAGNETIC RESONANCE OF PROTO IN THE WATER IN ZEOLITES. P.Ducros and X.Par
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 383-6 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The proton resonance consists of two lines equidistant in field from t resonance of the free proton. This shape can be related to the structure which consists of a rigid skeleton of tetrahedra of AlO and SiO_4 in which the water molecules fit. The water diffuses rapidly but the probability of the orientation of the molecule is n spherically symmetrical. The water can be replaced by other molecules such as D_2O. D.J.Ol

11769 NUCLEAR RELAXATION IN LIQUIDS. L.Giulotto.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 436-44 (1960)
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A ge al introductory review of nuclear spin–spin and spin–lattice relaxation phenomena in liquids. 60 references. E.F.W.Seym

11770 SOME RECENT EXPERIMENTS ON THE OVERHAUS ABRAGAM-EFFECT IN LIQUIDS.
W.Müller-Warmuth and P.Parikh.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 680-1 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Rece experiments on the Overhauser–Abragam effect using a sensitiv n.m.r. spectrometer are described. They include (i) measureme of weak magnetic fields, (ii) detection of very weak resonances a (iii) studies of proton resonance enhancements.
W.J.Orville-Tho

CROSS-RELAXATION EFFECTS IN MAGNETIC RESONANC See Abstr. 11491

11771 THE TENSILE STRENGTH OF LIQUIDS IN BERTHELOT TUBES. G.M.Lewis.
Proc. Phys. Soc. (GB) Vol. 78, Pt 1, 133-44 (July, 1961).

Experiments are described in which Berthelot tubes containing water are used in an attempt to estimate the maximum tension that can be sustained by a water–glass system under sta conditions. The Berthelot tube is sealed at both ends and is almo completely filled with the liquid under investigation. On heating tube the liquid expands until it completely fills the tube, but when is subsequently allowed to cool the adhesion of the liquid to the w of the tube prevents the liquid from contracting at a greater rate than the internal volume of the tube. Consequently a progressive increasing tension is set up in the liquid until it eventually ruptures. The tension in the liquid immediately prior to the instant of rupture is measured by estimating the sudden increase in the external volume of the Berthelot tube at this instant. The results show that the critical tension occurring in any one tube varies considerably in successive experiments; this variation is liable to be as great as thirty atmospheres. Furthermore, the magnitude of this tension varies from tube to tube; some tubes ca sustain sixty atmospheres while others are incapable of sustainin even five atmospheres. Experiments with tubes constructed fro steel gave substantially similar results. So also did glass tubes containing suspensions of ultramarine powder in water and carbo tetrachloride with water. Furthermore, pre-compression of the liquid has no detectable effect on the critical tension. Neither ha rate of build-up of the applied tension, nor mechanical shock. A incidental result has been the verification of the equality of the extensibility and compressibility of water.

MECHANICS OF GASES

'72 A NEW FORMULATION ['ANSATZ'] FOR HANDLING PROBLEMS OF GAS DYNAMICS INVOLVING LARGE .RTURES FROM THERMODYNAMIC EQUILIBRIUM.
itzsch.
Phys. (Germany), Vol. 7, No. 7-8, 403-17 (1961). In German.
t is proposed that for large departures from equilibrium a approximation to the velocity distribution can be found by an .ve superposition of two or more Maxwell distributions with ·ent means and variances (which can be functions of space of . To illustrate and test the method calculations were made tationary, strong shock waves with Mach numbers 3.00, 5.74). Detailed results are given for the thickness of the front and ·elocity distribution. The former (which amounts to three free . in the forward direction for the limit of infinite shocks) ırs to offer a smooth continuation of Zoller's results (Abstr. 125 52); the latter — in contrast to other calculations — is only ɔimodal in the plane of the shock and suggests that the true ion may remain unimodal. This analysis of shock waves can be rded merely as an extension of Mott—Smith's theory (Abstr. 6801 61) to a higher order, However the general ideas presented ɔotentially of wide application, the shock-wave case being, as ·re, a trial run. R.O.Davies

1773 THE STABILITY OF A ROTATING GAS COLUMN. J. Hazlehurst.
·ophys. J. (USA), Vol. 134, No. 1, 57-62 (July, 1961).
Rayleigh' s stability criterion, originally derived for incom- ;sible fluids, is found to have a more general validity.

1774 SUPERSONIC CURRENT OF [MATTER IN] TWO PHASES.
Charnyi, D.S.Vil'ker, B.I.Mitel'man and G.D.Rozenberg.
:. Akad. Nauk SSSR, Vol. 137, No. 1, 48 (March 1, 1961).
ussian.
Brief report of an experiment in which small quantities of ·r were injected into a jet of air moving at supersonic speed. ·reas initially both air and water had a temperature of 15°C, ing set in. A steel rod immersed in the jet was rapidly ·red with a crust of ice. R.Eisenschitz

ock Waves

1775 TWO-FLUID MODEL FOR THE STRUCTURE OF NEUTRAL SHOCK WAVES.
iering, F.Ek and P.Koch.
s. of Fluids (USA), Vol. 4, No. 8, 975-87 (Aug., 1961).
Recent measurements indicate that the thickness of weak and derate strength shocks ($M < 2$) is given accurately by the ier—Stokes equations, whereas there is good reason to believe the bimodal theory of Mott—Smith is a better description for ɔng shocks. It is therefore desirable to develop a theory that account for shock structure at both large and small Mach ɔber. Results of a promising two-fluid theory by Glansdorff are ɔmputed and the formulation is criticized. A modified two-fluid roach is developed, employing moments of the respective tzmann equations for each fluid, and employing an intermediate ɔwellian distribution function with a mean flow velocity and ɔerature at the centre of the shock to account for irreversible ticle transfer between the two fluids. Numerical solutions for d-sphere and inverse fifth molecules are given, and comparisons ı other solutions and experimental data are made. The results in substantial agreement with requirements at both large and ll Mach number.

INITIATION OF A LOW-DENSITY P.E.T N. PRESSING BY A NE SHOCK WAVE. See Abstr. 11621

MAGNETOHYDRODYNAMIC SHOCK STRUCTURE WITHOUT LLISIONS. See Abstr. 11934

11776 PROPERTIES OF THE SOLUTION OF THE PROBLEM OF POINT DETONATION IN COMPRESSIBLE TTER. N.N.Kochina and N.S.Mel'nikova.
kl. Akad. Nauk. SSSR, Vol. 138, No. 2, 326-9 (May 11, 1961).
Russian.
The propagation of the shock front is studied in terms of standard aerodynamical theory. The effect of initial conditions is assessed, in particular of the energy which is released during the detonation. [English translation in: Soviet Physics-Doklady (USA)]. R.Eisenschitz

11777 SHOCK WAVE PHENOMENA IN COAXIAL PLASMA GUNS. C.T.Chang.
Phys. of Fluids (USA), Vol. 4, No. 9, 1085-96 (Sept., 1961).
In a plasma gun (or a magnetically driven shock tube) shocks are usually obscured by a luminous front. Using a reflection technique and a pressure probe, the existence of a shock wave is confirmed experimentally. For weak shocks the luminous front lags definitely behind the shock front. For strong shocks there is an indication that the two fronts might coincide. The reflection technique also indicates the presence of a possible relaxation process. Since the amount of energy loss to the wall is not certain at present, no attempt is made to inquire further in the detail of the process. A simple analytical model is formulated, from which the shock speed is related to the discharge conditions. Some of the analytical results are compared with those obtained experimentally.

11778 MULTIPLE SHOCK WAVE STRUCTURES IN POLY-CRYSTALLINE FERROELECTRICS.
C.E.Reynolds and G.E.Seay.
J. appl. Phys. (USA), Vol. 32, No. 7, 1401-2 (July, 1961).
Two-wave shock structures were measured electrically and optically for three ferroelectric ceramics, $Pb(Zr,Ti)O_3$ with 1% Nb_2O_5, pure $BaTiO_3$, and $BaTiO_3$ with 5% $CaTiO_3$. For example, for the pure $BaTiO_3$ with 80 kbar second-wave pressure, the first-wave pressure and velocity were 24 kbar and 5.8 mm/μsec.
J.Hawgood

STATIONARY STRONG SHOCK WAVES. See Abstr. 11772

11779 SHOCK CURVATURE DUE TO BOUNDARY-LAYER EFFECTS IN A SHOCK TUBE. R.A.Hartunian.
Phys. of Fluids (USA), Vol. 4, No. 9, 1059-63 (Sept., 1961).
A two-dimensional, linearized treatment, including real gas effects, of shock curvature in a shock tube is presented. An expression for shock shape as a function of shock Mach number and initial pressure of the test gas is presented. The results are compared with the available experimental data obtained in argon at low shock strengths and in air at high shock Mach numbers. Within the scatter of the data in the latter experiments, there is relatively good agreement with theory, while theory falls approximately $30 \pm 10\%$ above the data in argon. Some of this disagreement is attributed to application of the two-dimensional theoretical result to axisymmetric shock tubes of finite dimensions used in the experiments.

11780 DIFFUSION IN A SLIGHTLY IONIZED GAS WITH APPLICATION TO EFFUSION FROM A SHOCK TUBE.
B.Sturtevant.
Phys. of Fluids (USA), Vol. 4, No. 9, 1064-73 (Sept., 1961).
A sampling technique for measuring the diffusive flux of charged particles from an ionized gas to a cold wall by measuring the effusive electrical current through a small orifice in the wall was used to study slightly ionized argon behind reflected shock waves. The technique is described and the transient diffusion process upon which it depends is considered in some detail. Computations based on a simple one-dimensional isothermal charge diffusion model illustrate the features and give the result that the effect of the electric body forces is generally greater on the ions and less on the electrons than originally expected. These results are used in an approximation to the nonisothermal problem to give a relation between the measured effusive current and the ion density in the hot gas. Preliminary observations of the dependence of ion density on time and temperature in the initial stages of ionization relaxation are reported. Simple considerations of the chemical kinetics indicate that for the portion of the process observed (degree of ionization about 10^{-5} times the equilibrium value), the ionization of argon results from a complicated series of consecutive reactions.

11781 INTERPRETATION OF HEAT GAUGE RECORDS IN SHOCK TUBE FLOWS. W.J.Hooker.
Phys. of Fluids (USA), Vol. 4, No. 6, 783-4 (June, 1961).
Observations on shock-heated CO indicate that the laminar-to-turbulent transition Reynolds numbers in the boundary layer behind the shock wave may not be reliably deduced from wall heat-gauge measurements unless other measurements define the extent of the hot flow. G.I.W.Llewelyn

GASEOUS STATE

11782 PRE-EXPONENTIAL FACTOR OF TEMPERATURE IN THE DIFFUSION EQUATION. R.H.Doremus.
J. chem. Phys. (USA), Vol. 34, No. 6, 2186-7 (June, 1961).

Comment on interpretation by Swets, Lee and Frank of their diffusion experiments (Abstr. 3685 of 1961), pointing out that their data can be fitted by the expression $D = 2.7 \times 10^{-7} T \exp(-4810/RT)$, and that this might tend to confirm some theoretical studies (Eyring, 1941). J.Hawgood

11783 COMMENTS ON DR. DOREMUS' LETTER. D.E.Swets, R.W.Lee and R.C.Frank.
J. chem. Phys. (USA), Vol. 34, No. 6, 2187 (June, 1961).

See preceding abstract. It is agreed that there are alternative ways of fitting the diffusion data, but it is pointed out that this could involve theoretical difficulties. J.Hawgood

11784 INVESTIGATIONS ON SUSPENDED PARTICLES IN DIFFUSING WATER VAPOUR. K.H.Schmitt.
Z. Naturforsch. (Germany), Vol. 16a, No. 2, 144-9 (Feb., 1961). In German.

A vapour which diffuses through a carrier gas in which small particles are suspended exerts a force upon these particles. The velocity of such particles was measured when water vapour diffused through nitrogen at pressures between 400 and 100 mm Hg. The velocity of the diffusing particles was independent of their radius within the range of a reduced particle radius from 0.05 to 0.5μ. It should therefore be possible to remove dust with diffusing water vapour. Experiments were also made with alcohol in a diffusion cloud chamber, and the effect of the carrier gas was examined. The tracks disappeared five times more quickly in hydrogen than in air. R.Schnurmann

DIFFUSION IN A SLIGHTLY IONIZED GAS. See Abstr. 11780

ON THE DISCONTUNUITY INVOLVED IN DIFFUSION ACROSS AN INTERFACE (THE Δ OF FUCHS). See Abstr. 11632

11785 PRESSURE–DENSITY ISENTROPES FOR ARGON AT TEMPERATURES BETWEEN 150°C AND –140°C AND AT PRESSURES UP TO 1950 ATM.
L.T.Ho, J.T.Vanderslice, R.J.Fallon, A.E.Seigel and Z.I.Slawsky.
Phys. of Fluids (USA), Vol. 4, No. 6, 784-6 (June, 1961).

11786 ESTIMATED COLLISION INTEGRALS FOR THE EXPONENTIAL ATTRACTIVE POTENTIAL.
R.S.Brokaw.
Phys. of Fluids (USA), Vol. 4, No. 8, 944-6 (Aug., 1961).

Collision integrals for the exponential attractive potential $\varphi(r) = -A \exp(-r/\rho)$ were estimated from the known integrals for the inverse power attractive potentials $\varphi(r) = -ar^{-n}$. The exponential attractive potential should be suitable for interactions between atoms or free radicals corresponding to bound molecular states, provided the temperature is not too high. Integrals for calculating the first Chapman–Enskog approximation to the coefficients of viscosity, thermal conductivity, and diffusion were estimated. The auxiliary functions A*, B*, and C*, which are required to calculate the coefficients of viscosity, thermal conductivity, and thermal diffusion in gas mixtures, are also tabulated. There is no simple way of assessing the accuracy of these estimates; however, when the same method is applied to the exponential repulsive potential, the estimated integrals agree with rigorously computed values to within 5% or better.

11787 MOLECULAR BEAM FOR THE STUDY OF HIGH-TEMPERATURE-GAS COLLISION PROCESSES.
G.T.Skinner.
Phys. of Fluids (USA), Vol. 4, No. 9, 1172-6 (Sept., 1961).

A high-intensity molecular beam is described, in which a tailored-interface shock tube is used as the gas source. The purpose of the apparatus is to extend molecular beam techniques into the 1-10 eV per particle range, in order to study collision in high-temperature gases. The principles of the apparatus are discussed. Experimental intensity profiles agree with the predicted profiles. A 0.7 eV nitrogen beam was produced in experiments which were designed to determine whether high-intensity high-energy beams could be obtained when the stagnation temperature of the gas is order of magnitude higher than the apparatus temperature.

ELECTRON BEHAVIOR IN GAS MIXTURES. See Abstr. 11

11788 RAYLEIGH'S RATIO AND TURBIDITY OF IMPERFE GASES. S.Kielich.
Acta phys. Polon. (Poland), Vol. 19, No. 6, 711-30 (1960).

General expressions for Rayleigh's ratio and the turbidity a given, containing the molecular constants S_m^{is} and S_m^{anis} of isotro and anisotropic light scattering. For imperfect gases, the const S_m^{is} and S_m^{anis} can be expressed as a virial expansion in inverse powers of the molar volume. The second virial coefficients B_S^{is} B_S^{anis} of isotropic and anisotropic light scattering are calculate certain molecular models of dipole and quadrupole molecules. T quantities are discussed and evaluated numerically for the impe gases CO_2, NH_3, CH_3F, CH_3CN and COS.

11789 DETERMINATION OF ISENTROPIC PRESSURE-DENSITY CURVES FOR ARGON FROM A RAPID DYNAMIC PROCESS. L.T.Ho, J.T.Vanderslice, R.J.Fallon, L.T.Ho, J.T.Vanderslice, R.J.Fallon, A.E.Seigel and Z.I.Slawsky
Phys. of Fluids (USA), Vol. 4, No. 8, 947-54 (Aug., 1961).

Isentropic pressure–density curves for argon were obtained from measurements on the rapid expansion of the gas behind a piston. Results are given for cases when the argon was initially at room temperature and at pressures of from 400 to 900 atm. The agreement with equilibrium data is good.

11790 INFRARED SPECTRA OF SOME GROUP IV HALIDE A.Büchler, J.B.Berkowitz-Mattuck and D.H.Dugre.
J. chem. Phys. (USA), Vol. 34, No. 6, 2202-3 (June, 1961).

Values of the asymmetric stretching frequency (ν_3) were measured for the gaseous tetrafluorides and tetrachlorides of zirconium, hafnium, and thorium. An estimate of 190 ± 20 cm^{-1} also made for the bending frequency (ν_4) of ZrF_4. D.L.Greena

11791 TEMPERATURE DEPENDENCE OF THE INFRARED ABSORPTION [BAND INTENSITIES] OF CARBON TETRACHLORIDE IN A GASEOUS STATE.
M.P.Lȳsȳtsya and V.M.Malȳnko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 773-8 (1958). In Ukraini

Quantitative investigations qualitatively confirmed the basic conclusion of existing theory, i.e. an increase in absorption with a rise in temperature. There is, however, no complete quantitat correlation, since the theoretical curve is markedly steeper than the experimental one.

11792 INFRARED CHEMILUMINESCENCE IN THE SYSTEM H + NOCl. J.K.Cashion and J.C.Polanyi.
J. chem. Phys. (USA), Vol. 35, No. 2, 600-7 (Aug., 1961).

Infrared emission was observed arising from the low-press gas-phase system H + NOCl; HCl emission consists of the funda mental spectrum ($\Delta v = 1$), and first and second overtones ($\Delta v = 2$ and 3) of the ground electronic state. $HCl^{\dagger}$ (vibrationally excited HCl in its ground electronic state) must be present in levels up t and including $v = 9$ (possibly 10). The distribution of $HCl^{\dagger}$ among vibrational levels in non-Boltzmann, indicating that some or all formed by a chemical reaction rather than a thermal process. T reaction is thought to be $H + NOCl \rightarrow HCl^{\dagger} + NO$. Only a weak emis due to $NO^{\dagger}$ was observed. An emission of intensity comparable t $HCl^{\dagger}$ was observed in the region of the ω_1 fundamental of NOCl. From the stationary state distribution of $HCl^{\dagger}$ among vibrational levels a calculation was made of the relative rate constants k_v f reaction into each accessible vibrational level of $HCl^{\dagger}$. An exam tion of the stationary state distribution of $HCl^{\dagger}_{v=1}$ among rotatio levels indicates that while the over-all distribution is non-Boltz rotators in high rotational levels are in approximate equilibrium ~2000°K and rotators in the lowest levels are in a distribution w roughly corresponds to that for 650°K. The absolute intensity of infrared emission was found to be ~0.05W. This is equivalent t roughly 0.2 to 2.0% of the energy liberated by the reaction. Fro the emission intensity the partial pressure of $HCl^{\dagger}_{v=1}$ was calcu ed to be $\sim 6 \times 10^{-3}$ mm Hg, that is ~0.3% of the total reagent pressure.

793 STATISTICAL THEORY OF THE DIELECTRIC CONSTANT OF AN IMPERFECT GAS.
Kaufman and K.M.Watson.
. of Fluids (USA), Vol. 4, No. 8, 931-43 (Aug., 1961).
By means of the linked-diagram expansion of the grand partition ion of a molecular gas in an electrostatic field, an expression for olarization $\vec{P}(\vec{R})$ of the gas is obtained. Spatial variation of xternal electric field $\vec{E}_0(\vec{R})$ requires an explicit treatment of range cooperative interactions between "clusters" of molecules. ields that vary appreciably over microscopic dimensions, an ral relation is found relating the polarization $\vec{P}(\vec{R})$ to the ric field $\vec{E}(\vec{R})$. For fields varying negligibly over microscopic ns, an expression for the dielectric constant K of the gas is ned: $(K-1)/(K+2) = (4/3\pi)\Sigma_{m=1}^{\infty} n^m \alpha_m(\theta)$. This generalization e Clausius–Mossotti formula involves the density n and the erature-dependent polarizabilities of m-molecule linked ters: $\alpha_1(\theta)$ is the effective polarizability of a single (possibly r) molecule; $\alpha_2(\theta)$ is the diagonal element of the scalar tensor) = $\int d^3R \exp\{-\beta\Phi(\theta,R)\}[\frac{1}{2}\alpha_2(\theta,\vec{R}) - \alpha_1(\theta)]$. In this expression $\vec{R})$ is the effective polarizability tensor of two molecules with i positions of their centres of mass; Φ is the free energy of the molecule system, relative to infinite separation.

VACUUM PHYSICS

11794 THE KINETICS OF PUMPING OF VACUUM SYSTEMS IN THE QUASI-STATIONARY REGIME. V.A.Malyshev.
tekh. Fiz. (USSR), Vol. 31, No. 2, 200-3 (Feb., 1961). In Russian.
For abstract, see Abstr. 5303 of 1961. [English translation in iet Physics–Technical Physics (USA), Vol. 6, No. 2, 143-5 g., 1961)].

11795 A SMALL GETTER ION-PUMP.
A.Klopfer and W.Ermrich.
lips tech. Rev. (Netherlands), Vol. 22, No. 8, 260-5 (1960-61).
For evacuating certain types of electron tubes, use can be made t getter ion-pump. Because of its compactness, light weight and cost, many special types of electron tubes can retain their own ap throughout their working life. This article describes a getter -pump using titanium as getter material. Ionization takes place in a Penning vacuum gauge; the titanium itself sustains the nning discharge. With its reserve of 50 mg of titanium the pump n remove a total of 2.5 torr litre of CO. The maximum pumping eed is 62 l./sec. The lowest pressure achieved in small vacuum stem is roughly 10^{-10} torr.

11796 COMMENTS ON "ERRONEOUS READINGS OF LARGE MAGNITUDE IN A BAYARD-ALPERT IONIZATION AUGE AND THEIR PROBABLE CAUSE". C.K.Crawford.
v. sci. Instrum. (USA), Vol. 32, No. 4, 463-4 (April, 1961).
In the papers by Barnes (Abstr. 12439 and 19226 of 1960) a ld ion vacuum gauge was described with which the unreliability Bayard–Alpert Gauges was meant to be demonstrated. The perimental work as well as the explanations and conclusions ob- ned in these papers are severely criticized for a number of asons: there was no comparison with an independent third gauge ch as McLeod; no complete calibration curves were published; unreliable method of pressure control was used. Finally, the planation given by Barnes for the supposed cause of pressure ferentials is attacked: under normal conditions the glass could become sufficiently hot to decompose and produce potassium or dium ions; the probability of photo ionization is shown to be gligible; the lifetime of potassium ions in the grid to wall space too short to maintain a space charge; the vapour pressure of tassium or sodium is too small to affect the comparison gauge.
W.Steckelmacher

11797 COMMENTS ON THE BARNES COLD CATHODE GAUGE. W.B.Nottingham.
v. sci. Instrum. (USA), Vol. 32, No. 4, 464-5 (April, 1961).
The field ion gauge discussed in the paper by Barnes (Abstr. 439 of 1960) had not been proven to be reliable and was useless a means of evaluating vacuum conditions. Barnes is criticized using various Bayard–Alpert gauges as a reference (instead of McLeod) without regard for the nature of the gas whose pressure s evaluated in terms of the ionization current. A second paper Barnes (Abstr. 19226 of 1960) implied that glass heated by Bayard–Alpert gauge filaments produced many ions (sodium and potassium) completely undetected by the Bayard–Alpert gauge yet measured by the Barnes gauge. It is concluded that no evidence in these papers was a valid evaluation of the usefulness or accuracy of Bayard–Alpert type gauges. W.Steckelmacher

11798 NEW THERMIONIC IONIZATION GAUGE.
N.A.Florescu.
Vide (France), Vol. 16, 10-17 (Jan.-Feb., 1961).
In English and French.
A new design of ionization gauge is described, in which the two electrodes acting as electron emitter and ion collector, respectively, are placed inside a positive grid having the form of a helical coil. A convenient construction is obtained by using two similar filaments, either one of which can be used as the ion collector. A thorough degassing being easily achieved, the gauge is suitable for the measurement of extreme vacua.

11799 BARKHAUSEN OSCILLATIONS IN IONIZATION GAUGES. J.Pierre.
Vide (France), Vol. 16, 18-22 (Jan.-Feb., 1961).
In English and French.
It has often been noticed that, under particular conditions, very high-frequency oscillations take place in ionization gauges of the triode type. This phenomenon is unwanted, as, on one hand it changes the gauge sensitivity, and, on the other hand, supply leaks disturb its operation. The paper is directed to the analysis of this phenomenon and to means of avoiding unwanted oscillations.

11800 ALUMINIUM BAKEABLE VACUUM SEAL.
L.Holland.
J. sci. Instrum. (GB), Vol. 38, No. 8, 339 (Aug., 1961).

METAL-TO-GLASS VACUUM SEAL FOR LOW TEMPERATURES. See Abstr. 11868

11801 A SYSTEM OF GAS SAMPLE BOTTLES WITH METALLIC VACUUM CONNECTIONS. Ya.A.Yukhvidin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 3, 105 (May-June).
In Russian.
Glass bottles were connected by glass–metal tubular seals to all-metal bellows valves terminating in demountable metal-gasketed joints. These joints were designed for tightening by a quick acting cam-operated clamp onto the manifold of a mass spectrometer sampling system. [English translation in: Instrum. exper. Tech. (USA), No. 3, 438-9 (May-June, 1958; publ. June, 1959)].
W.Steckelmacher

11802 SIMPLE ARRANGEMENT FOR EVAPORATING MULTI-LAYER FILMS THROUGH DIFFERENT MASKS IN ULTRAHIGH VACUUM. J.P.Hoekstra and P.White.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 362-3 (March, 1961).
A device for magnetically actuating multiple masks from outside the evaporation chamber (10^{-8} mm Hg) avoids the difficulties of baking out sliding seals, and of increased friction between completely outgassed metal surfaces. V.J.Hammond

11803 HOLLOW CATHODE DISCHARGES IN VACUUM DEPOSITION SYSTEMS. H. van Paassen.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 871-2 (July, 1961).
Describes positioning and use of hollow Mo cathode (for discharge cleaning of substrate for vacuum deposition) having the same effect as less practical system of Holland (Abstr. 3578 of 1960).
V.J.Hammond

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

11804 RESPONSE OF A SINGLE-DEGREE-OF-FREEDOM ISOLATOR TO A RANDOM DISTURBANCE.
S.Kaufman, W.L.Lapinski and R.C.McCaa.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1108-12 (Aug., 1961).

A method is presented for computing acceleration, deflection, and velocity response of a damped, single-degree-of-freedom isolator, subject to a random disturbance between finite frequency limits. A closed-form solution is obtained for the case where the power spectral density is constant within any given bandwidth. The results are plotted in such a manner that the responses to a variable power spectral density function can readily be computed.

11805 ON VIBRATIONS OF SHALLOW SPHERICAL SHELLS. A.Kalnins.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1102-7 (Aug., 1961).

The vibration analysis of shallow spherical shells is extended to (a) frequencies of the order of magnitude of the first thickness-shear mode in an infinite plate and (b) moderately thick shells. A tenth-order system of three uncoupled differential equations is derived, which govern the nonsymmetric dynamic deformation of a shallow spherical shell subjected to arbitrary time-dependent surface loads, and separable solutions are obtained in terms of Bessel functions. As an example, a frequency equation is deduced for the determination of natural frequencies higher than those accurately predicted by the classical theory for free vibration of a shallow spherical cap with a clamped edge.

11806 A THEORY OF DAMPING OF ELASTIC VIBRATIONS IN TWO-PHASE MIXTURES. M.A.Krivoglaz.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 497-512 (Oct., 1960). In Russian.

Gives a theory of a mechanism of elastic vibration damping due to changes in phase equilibrium produced by the passage of an elastic wave through a two-phase mixture. Deals with the frequency dependences of the velocity and the absorption coefficient of acoustic waves, and with the internal friction in mixtures with various types of phase transition. Discusses one-component two-phase systems and two-phase solid solutions. A.Tybulewicz

11807 SCATTERING OF PLANE WAVES BY A RIGID RIBBON IN A SOLID. K.Haruml.
J. appl. Phys. (USA), Vol. 32, No. 8, 1488-97 (Aug., 1961).

The scattering of plane compressional and shearing waves by an infinitely long rigid ribbon with width a in an elastic medium is computed by the use of the Mathieu functions. The diffraction patterns for ka/2 = 1,2, and 4 are calculated numerically; the distributions-in-angle of the elastic waves bears no resemblance to that of the sound except for the normally incident compressional wave. The expressions for the scattering field and cross-section, in powers of ka = h, are obtained in the Rayleigh case. In this case the scattering cross-section is of the order of the wavelength, as it is in the case of the scattering of the sound by an absorbing ribbon. Some new expansions of the Mathieu functions in powers of h are listed in an appendix.

11808 REFLECTION AND POLARIZATION OF ELASTIC WAVES IN A LiF CRYSTAL: MODE CONVERSION FROM LONGITUDINAL TO TRANSVERSE. N. Joel.
Proc. Phys. Soc. (GB), Vol. 78, Pt I, 38-45 (July, 1961).

An experiment is described in which a longitudinal wave of ultrasonic frequency travelling in a crystal of LiF (anisotropic medium) is incident on a crystal–air boundary and is reflected as a transverse wave. Such a mode conversion, or complete change in the state of polarization, of an elastic wave had previously been observed only in isotropic media. The corresponding calculations are also given; they agree with the experimental results.

11809 REFLECTION FROM A THIN INFINITE PLATE USING THE EPSTEIN METHOD. R.R.Goodman.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1096-8 (Aug., 1961).

In the calculations concerning the vibrations of thin elastic shells, several approximations called "shell-theories" have been introduced in an attempt to simplify the mathematical formalism. In this paper one of these approximation methods, known as the Epstein method, is used to obtain the reflected field produced by a plane wave impinging on an infinite plate. The results are given first order in kh, where k is the wave number and 2h is the thickness of the plate. A comparison with the exact results shows exact agreement to first order.

ACOUSTICS

11810 NEW EQUATION FOR THE ASYMPTOTIC FIELD AMPLITUDE IN A TWO-DIMENSIONAL INHOMOGEOUS MEDIUM. I.Kay.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1085-90 (Aug., 1961).

The geometrical or high-frequency approximation to solutio of the two-dimensional wave equation in an inhomogeneous medi is considered. A new ordinary differential equation for a quanti which is inversely proportional to the geometrical high-frequenc field intensity (the square of the field amplitude) is derived. Thi equation, along with the standard ray and phase equations form a system form which a complete wave solution in the high-frequen asymptotic limit can be calculated numerically, e.g. through the of a differential analyser. The examples of a homogeneous medi and a plane stratified inhomogeneous medium are discussed, and the results of the preceding analysis are verified in these two special cases.

11811 COMPLEX IMAGE THEORY OF LOW-FREQUENCY SOUND PROPAGATION IN SHALLOW WATER.
E.G.McLeroy.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1120-6 (Aug., 1961).

The problem of propagation of low-frequency sound in shallo water over several layers and a basement is approached through an image theory in which the first thin layers are lumped togethe with the water layer. This effective structure is assumed on the basis of expected good transmission through a thin layer (less th one wavelength thick) having acoustic properties not very differe from those of its bounding media. The required reflection coeffi cient at the lower boundary of the lumped layer, expressed as a function of range and the order of the image source of a ray, is taken in the form given by Abelés for reflection of plane waves from a layered system. The theory yields calculated transmissi loss functions which show reasonable agreement with experiment results. Comparisons of theoretical loss and data obtained at Panama City, Florida, are made over the frequency range 6-244

11812 ON THE ROLE OF MICROBUBBLES IN THE NON-LINEAR TRANSMISSION OF SOUND IN LIQUIDS.
C.E.Adams and F.J.Jackson.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1145-6 (Aug., 1961).

The harmonic content of 25 kc/s sound transmitted through water was measured as a function of ambient pressure (0-12 atm and an inverse relationship was found to hold; the nonlinearity disappeared completely at the higher pressures. It is suggested that gaseous cavitation, a pressure-dependent phenomenon, may involved as a mechanism in the sound transmission.

11813 ON THE PROPAGATION OF SOUND IN A LIQUID CONTAINING GAS BUBBLES.
Din-Yu Hsieh and M.S.Plesset.
Phys. of Fluids (USA), Vol. 4, No. 8, 970-5 (Aug., 1961).

The theory of the propagation of sound in a homogeneous gas including the effect of heat conduction is presented for the purpos of clarifying the underlying thermodynamic process. The propag tion of sound in a liquid with a homogeneous and isotropic distrib tion of gas bubbles is then considered. The bubbles are assumed be sufficiently small and numerous so that the mixture can be tak to be a uniform medium. The effect of heat conduction is include If f is the ratio of gas volume in the mixture to liquid volume, it shown for the range of f of general interest that the acoustic condensations and rarefactions of the gaseous portion of the medi are essentially isothermal. It is also found that the attenuation o an acoustic disturbance by heat conduction is quite small.

11814 HORIZONTAL REFRACTION IN A THREE-DIMENSIONAL MEDIUM OF VARIABLE STRATIFICATION.
D.E.Weston.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 46-52 (July, 1961).

In the sea the repeated horizontal deflection of a sound ray to reflection at a sloping bottom produces a curvature of the horizontal path. The reflection angles in three dimensions are

ulated for a sloping bottom or sound velocity interface. Even if tratification varies in both horizontal directions there is, for variations, a simple relation between the changes in vertical orizontal ray angle. It is then shown that the horizontal cure may be predicted by associating a refractive index or phase city with each horizontal position. A formula for intensity and e illustrative problems are presented. For example it is shown on reflection from a coastline the vertical ray angle at closest oach is equal to half the total horizontal angle through which ray is turned.

11815 FURTHER STUDIES OF THE INFLUENCE OF ACOUSTIC MICROSTREAMING ON THE PHOTOGRAPHIC DEVELOPMENT PROCESS. F.J.Jackson.
Acoust. Soc. Amer., Vol. 33, No. 8, 1144-5 (Aug., 1961).

A major obstacle in attempting quantitative investigations of influence of microstreaming on solid-liquid interface reactions been the inability to prevent gaseous cavitation (which destroys orderly streaming action) from occurring in the liquid medium n the latter is subjected to a high-amplitude sound field. The sent article describes a modification of an earlier experimental angement, used to study microstreaming effects on a specific rphase chemical reaction (i.e. development of a photographic lsion), which incorporates a means for suppressing undesired itation. Preliminary results obtained using this apparatus are sented. These results permit a more precise correlation ween observed effects and properties of the streaming field than hitherto been possible. Preliminary data indicating the extent which microstreaming affects the local development rate are also sented.

11816 IMPROVED QUASI-STEREOPHONY AND "COLORLESS" ARTIFICIAL REVERBERATION. M.R.Schroeder.
Acoust. Soc. Amer., Vol. 33, No. 8, 1061-4 (Aug., 1961).

"Quasi-stereophony" is defined as the reproduction over two or re loudspeakers (or binaural earphones) of different sound signals ived from a single audio signal. The purpose of quasi-stereony is to create (from a single audio signal) an illusion of spatially tributed sound sources. Quasi-stereophonic reproduction does permit correct localization but does share with true stereony the properties of "depth" and "ambience" which are important ributes of stereophony (for the casual listener perhaps even more portant than correct localization). This paper describes a new ering method for producing quasi-stereophony. In contrast to lier proposals, the new filtering method leaves the amplitude ctrum of the sound intact. The same kind of filter has also been ed for generating "colourless" artificial reverberation. Experintal results indicate that both quasi-stereophony and artificial verberation can be achieved without spectral distortion.

nstruments and Measurements

11817 HEARING AND SEEING BEATS. O.E.Kruse.
mer. J. Phys., Vol. 29, No. 9, 645 (Sept., 1961).

An apparatus using two audio oscillators is described.

E.G.Knowles

11818 EFFECT OF A LONGITUDINAL STATIC PRESSURE UPON A MAGNETOSTRICTIVE FERRITE. L.Wilson.
Acoust. Soc. Amer., Vol. 33, No. 8, 1127-30 (Aug., 1961).

Double-dumbbell transducer elements of two commercial ckel–copper–cobalt–ferrous ferrites (Ferroxcube 7A1 and 7A2) with oustic "pressure-release" material at each end were placed tween the jaws of a hydraulic pressure testing machine. The fective electromechanical coupling coefficient for the sample was easured for various magnetizing currents and static loads. As e load was increased to 5600 lb, corresponding to 4600 lb/in^2 the narrow "limbs" of the element, the effective coupling coeffient at optimum bias decreased from 0.21 to 0.05, and the clamped ductance (which is proportional to the incremental permeability) creased by 40%.

11819 OPTIMUM ENVELOPE RESOLUTION IN AN ARRAY CORRELATOR. M.J.Jacobson.
Acoust. Soc. Amer., Vol. 33, No. 8, 1055-60 (Aug., 1961).

A correlator detector is considered which processes the outts of two identical collinear arrays of uniformly spaced elements. When the input signal is sinusoidal, the mean system output is bounded by the product of the space factors of the arrays. Complex amplitude factors are introduced following each element, and it is shown how to choose them in order to optimize the main-lobe-width–side-lobe-level relationship of the space-factor product or envelope. In addition, it is proved that the use of the amplitude factors for improving envelope resolution gives rise to a signal-noise degradation relative to the corresponding uniform amplitude system. Various numerical results are given, including the fact that the optimum system provides an envelope main-lobe-width reduction of approximately 30% when twenty or fewer elements appear in each array.

11820 THREE-ELEMENT STAGGER-TUNED TRANSDUCER ARRAY FOR BROADBAND OPERATION. T.F.Hueter and W.E.Currie.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1146-7 (Aug., 1961).

This investigation was conducted to determine the feasibility of a compact, lightweight, multi-element broadband transducer. Three bender-type elements with proportionately spaced resonant frequencies were assembled in a cluster. The assembly proved capable of radiating from 1.75 to 2.70 kc/s with not more than ±1.5 dB power variation, if the elements were properly spaced. This investigation demonstrated that low-Q devices can be constructed from a combination of stagger-tuned high-Q elements providing that proper orientation and spacing are observed.

11821 AMPLIFICATION OF 9.3 kMc/sec ULTRASONIC PULSES BY MASER ACTION IN RUBY. E.B.Tucker.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 547-8 (May 15, 1961).

Reports observation of the amplification of 9.3 kMc/s ultrasonic pulses by a ruby rod in the maser condition through the phonon–spin interaction. The experiment was carried out at 1.5°K. Gain observed was 0.12 per cm of path in the ruby. It appears that gains obtainable may be sufficiently large to overcome system losses. The experiment represents the first observation of amplification of energy other than electromagnetic by quantum electronic methods.

P.M.Parker

Noise . Architectural Acoustics

11822 "NEAR FIELD" NOISE FROM TURBULENT JETS. D.W.Jorgensen.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 817 (June, 1961).

With the use of a hydraulic flow facility, noise spectra were obtained in the "near field" region of submerged water jets. Data obtained indicate that the sound is nearly independent of Mach number and Reynolds number for the range covered. Mach number extended from 0.008 to 0.02 and Reynolds number from 125 000 to 750 000.

B.Brown

11823 NOISE MEASUREMENTS AROUND A SUBSONIC AIR JET IMPINGING ON A PLANE, RIGID SURFACE A.H.Marsh.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1065-6 (Aug., 1961).

Measurements are presented of the noise produced by a 1.5 in. diameter air jet, with an exit Mach number of 0.66, impinging perpendicularly on a plane, rigid plate. The over-all sound power output increased rapidly, as the nozzle-to-plate separation distance was decreased. The over-all sound power generated, when the plate was 2 diameters from the nozzle, was 10 dB greater than that produced with the plate removed. For a 2 diameter separation the over-all sound pressure levels (SPL's) (measured at a radius of 24 nozzle diameters from the centre of the jet exit in the horizontal plane through the jet centreline) were 15 to 18 dB greater than those produced at corresponding positions with the plate removed, while for a 20 diameter separation, the increase varied between 2 and 7 dB. The spectrum of the noise changed as follows as the separation distance was increased: (a) the peak frequency decreased, (b) the pronounced peak changed to a broad one, and (c) the magnitude of the peak decreased.

11824 CRITIQUE OF THE REVERBERANT ROOM METHOD OF MEASURING AIR-BORNE SOUND TRANSMISSION LOSS. T.Mariner.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1131-9 (Aug., 1961).

Some obscure but important philosophical difficulties with the standard method of measuring transmission loss by the reverberant

room method have led to re-examination of the basic concepts. An equation is derived relating transmission loss to the "total loss area" H_2 of the receiving room. H_2 is found to measurable within a negligibly small uncertainty, using familiar sound-decay techniques, providing that T_2/T_1, the ratio of "natural" reverberation times of the receiving and source rooms is properly adjusted. It is shown that the equations commonly used in the existing standard method require knowledge of A_2, the total absorption of the receiving room, implicitly excluding transmission through the panel. A_2 is not generally measurable without prior knowledge of the transmission loss of the test panel. These and other considerations result in the proposal of a new procedure.

IMPROVED QUASI-STEREOPHONY AND "COLOURLESS" ARTIFICIAL REVERBERATION. See Abstr. 11816

OPTICS . PHOTOMETRY

11825 REMARK CONCERNING L.M.FALICOV'S PAPER "THE THEORY OF PHOTON PACKETS AND THE LENNUIER EFFECT". G.Beck.
Nuovo Cimento (Italy), Vol. 19, No. 4, 825 (Feb. 16, 1961).

Questions some of the assumptions, methods and conclusions of Falicov's paper (Abstr. 14780 of 1960). J.Hawgood

11826 PHOTON DEGENERACY IN LIGHT FROM OPTICAL MASER AND OTHER SOURCES. L.Mandel.
J. Opt. Soc. Amer., Vol. 51, No. 7, 797-8 (July, 1961).

The expression for the degeneracy is discussed for a beam of light, and is shown to be given to good approximation by the Einstein expression for degeneracy of black body radiation in an enclosure. It follows that, for normal incandescent sources at temperatures of a few thousand degrees K, beams have degeneracies of the order of 10^{-4}, while values of the order of 10^{-3} are obtainable from gas discharge sources. In optical masers, on the other hand, with surface coherence across the source, degeneracies as high as 5×10^7, or even of the order of 10^{12}, are observed. Suggestions are made as to how this property will be of great value in laboratory experiments involving photon correlation. J.Sheridan

11827 SPECTRAL SENSITIVITY DETERMINATIONS BY CUTOFF FILTERS. N.Mori.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1015-23 (Sept., 1961).

A series of 26 selenium glass filters with cutoffs uniformly paced over the visible spectrum is used as the basic set of filters to determine the relative spectral sensitivity function of a given photoelectric receiver. Certain characteristics of these filters, such as non-uniformity of transmittance across the filter surface and temperature dependence, impair the precision of the transmittance measurements as well as photocell-response measurements. Nevertheless it is possible to derive fairly well-conditioned matrices of difference functions obtained from the basic set of cut-off filters, which will allow a satisfactory determination of a spectral sensitivity function. Experimental as well as numerical implications are discussed in detail on the basis of a practical example.

TRANSFORMATION OF OBSERVED RADIANCES INTO RADIAL DISTRIBUTION OF THE EMISSION OF A PLASMA. See Abstr. 11937

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

11828 OPTIMUM MODULATION CHARACTERISTICS FOR AMPLITUDE-MODULATED AND FREQUENCY-MODULATED INFRARED SYSTEMS. T.B.Buttweiler.
J. Opt. Soc. Amer., Vol. 51, No. 9 1011-15 (Sept., 1961).

In the detection of infrared radiation, it is common practice interrupt the incident beam periodically to produce an alternatin signal for electronic processing; the means used to accomplish is usually a multisectored spinning aperture called a reticle. A comparison of reticle-produced amplitude- and frequency-modul waves was made. By calculating the power content of each component of the frequency spectrum of a modulated wave, the optim values for the parameters of bandwidth and modulation index hav been determined. It is shown that an FM system with a modulati index of 1.8 and a bandwidth encompassing only the first sideban pair exhibits the highest effective signal-to-noise ratio. Using these values of bandwidth and modulation index, the FM system exhibits a slight effective signal-to-noise superiority when compa with an AM system operating under similar conditions. The superiority of effective signal-to-noise ratio is lost if either the bandwidth or modulation index departs markedly from the optimu value. The modulation efficiency for various recticle-produced modulated waves has also been calculated.

11829 MODULATION OF LIGHT BY MEANS OF AN ELECT FIELD. B.H.Claussen.
Proc. Phys. Soc. (GB), Vol. 77, Pt 5, 1100-1 (May, 1961).

An attempt was made to modulate light reflected from a ger ium surface by varying the surface charge. This charge was fie induced by means of a transparent electrode separated from the germanium surface by a dielectric sheet. Modulation depths as as 35% were obtained, which is an order of magnitude higher tha theory predicts. Further investigation showed that this modulati was not electrical in nature but depended upon the variation of th optical path produced when the dielectric was displaced slightly the inducing field. A.J.

11830 A METHOD OF MAKING A RONCHI TEST ON AN ASPHERIC MIRROR. E.Lumley.
Atti Fond. Ronchi (Italy), Vol. 15, No. 5, 457-60 (Sept.-Oct., 196

The shape of two Ronchi shadow bands are computed and a soldered wire grid is made to this shape and hung on the mirror face. The mirror surface is then figured until the shadow bands fit the grid. A typical computation for a paraboloid is given and interpretation of departures from the computed shadow bands is described in detail. R.W.

11831 NUMERICAL TABLES FOR THE REFLECTIVITIES AT THE SOLID SURFACE.
K.Ishiguro, T.Sasaki and S.Nomura.
Sci. Pap. Coll. Gen. Educ. Univ. Tokyo (Japan), Vol. 10, No. 2, 207-15 (Dec., 1960).

The graphical method for determining the complex refractiv index, $n - ik$, of a solid from the reflectivities measured at two different incidence angles ϕ, proposed by Simon (Abstr. 5270 of 1951), is presented in a modified form. Sample graphs, compute for $\phi = 20^\circ, 45^\circ, 70^\circ$, in which the reflectivities at any two of the ϕ values are plotted along the axes, enable n and k to be read off separately from a single graph. E.A.Muss

11832 MAGNIFICATIONS OF A TELESCOPE. R.E.Stephens.
J. Opt. Soc. Amer., Vol. 51, No. 7, 803-4 (July, 1961).

A rigorous derivation of the various magnifications of a telescope is given. A more usual analysis is shown to be in error because of an incorrect estimate of the limiting value of an indeterminate ratio, even though it gives the correct value of angular magnification. The new method is applied to a simple Galilean telescope. R.W.F

833 APERTOMETER FOR MICROSCOPE OBJECTIVES. C.J.D.Spencer and W.T.Welford.
i. Instrum. (GB), Vol. 38, No. 8, 328 (Aug., 1961).
In conventional apertometers accuracy is limited by parallax
en the effective aperture stop and the scale image. This is
come by the use of a projection system in the device described.

1834 PHASE AND MODULATION FLUOROMETER. J.B.Birks and D.J.Dyson.
i. Instrum. (GB), Vol. 38, No. 7, 282-5 (July, 1961).
The instrument, which is designed for the measurement of
escence decay times of 10^{-7}–10^{-9} s, comprises a 10 Mc/s
ogen discharge lamp, fast photomultiplier, variable delay line
detector circuit for phase and modulation analysis of light
als from the lamp and specimen. Studies were made of the
sit time variations in 56 AVP and 6810 A photomultipliers,
preliminary measurements were made of the fluorescence
y time of quinine sulphate solutions.

11835 ULTRA-VIOLET ABSORPTION OPTICAL SYSTEM WITH PHOTOELECTRIC RECORDING FOR A PHYWE TRACENTRIFUGE. J.B.T.Aten and A.Schouten.
ci. Instrum. (GB), Vol. 38, No. 8, 325-7 (Aug., 1961).
The intensity of a parallel beam of ultra-violet light trans-
ted by the solution in an ultracentrifuge cell is measured by
nning the enlarged cell image with a photomultiplier. The
ctronic circuit permits the measurement of both transmission
optical density.

11836 APPARATUS FOR THE MEASUREMENT OF VACUUM ULTRAVIOLET OPTICAL PROPERTIES OF FRESHLY APORATED FILMS BEFORE EXPOSURE TO AIR.
).Madden and L.R.Canfield.
Opt. Soc. Amer., Vol. 51, No. 8, 838-45 (Aug., 1961).
An apparatus for the measurement of reflectance and trans-
tance is described which, with a specially constructed vacuum
porator and a monochromator, enables the study of the optical
perties of thin films in the wavelength region 500 A to 2000 A. The
ical measurements can be made immediately after the samples
prepared without exposing them to air. The apparatus allows the
asurement of sample transmittance, and sample reflectance can
determined as a function of incidence angle. The light source is
ferentially chopped to sort the grating orders, eliminate d.c.
ft and improve the signal-to-scatter ratio by a factor of 10 to 20.
me of the results obtained with this instrument are presented. It
shown that the reflectance of aluminium at λ1216 A decays
bstantially in vacuum (5×10^{-6} mm Hg) even in the first minutes
er deposition, and decreases by a factor of 2 after one day in air.
value of over 70% is indicated for the initial normal incidence
flectance of aluminium at λ1216 A, which is considerably higher
an previously reported. It is shown that the reflectance of platinum
mains essentially constant after deposition. Other data on the
flectance of aluminium, platinum, and rhodium are presented.

11837 METHODS OF OBTAINING THE RAMAN SPECTRA OF POWDERED CRYSTALS. J.Behringer.
turwissenschaften (Germany), Vol. 48, No. 3, 68 (1961).
German.
Methods are described in which the material is in tablet form
d (1) the scattered radiation transmitted through the tablet is
aged on the slit; or (2) the scattered radiation is first reflected
om a second tablet placed at 10° to the first. The second method
useful for absorbant materials. G.F.Lothian

11838 FOUR-SPECIMEN LIQUID-HELIUM CRYOSTAT FOR FLUORESCENCE. F.R.Lipsett.
ev. sci. Instrum. (USA), Vol. 32, No. 7, 840-1 (July, 1961).
A cryostat is described in which the fluorescence spectra of
ur solid specimens may be obtained by rotating each specimen in
rn into focus by means of a tube operated externally. Although
signed primarily for obtaining fluorescence spectra in "reflection",
e cryostat may also be used to obtain such spectra in "trans-
ission" or for the measurement of conventional absorption spectra.
elium is used as a transfer gas and the temperature is determined
a Bourdon pressure gauge used as a gas thermometer. The level of
quid helium in the reservoir is determined with the help of carbon
sistors. The specimens are mounted on a small cage which may
sily be removed from the cryostat and sealed back into place with
indium gasket. The cryostat is made of metal and is easily
mountable.

11839 AUTOMATIC RECORDING MICROPHOTOMETER. G.Monod-Herzen.
J. Phys. Radium (France), Vol. 21, No. 2, 142-3 (Feb., 1960).
In French.
A recording instrument is made by fitting to the wavelength
drive of a photoelectric spectrometer a reversible motor which is
synchronous with the pen recorder motor. A cam on the wavelength
drive puts calibration marks on the record. G.F.Lothian

11840 SYSTEM FOR MICROSPECTROPHOTOMETRY EMPLOYING A COMMERCIAL RECORDING SPECTROPHOTOMETER. P.K.Brown.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1000-8 (Sept., 1961).
The present paper describes the design and performance of an
attachment for the Cary model 14 recording spectrophotometer,
which permits the accurate recording of absorption spectra in small
areas. A special compartment built into the light path of the spectro-
photometer holds a low-magnification microscope ("macroscope")
consisting of two opposed quartz condensers, with which measure-
ments can be made between 300 and 700 mμ in fields 0.1 to 1 mm in
diameter. This can be replaced by a conventional microscope with
which spectra can be measured from about 350-650 mμ in fields as
small as 4 μ in diameter. These arrangements have been used to
measure the absorption spectra of visual pigments in situ. With the
macroscope, such measurements have been made in small areas of
surviving retinas; and with the microscope, they have been made in
single isolated outer segments of rods. The present paper contains
examples of each type of measurement.

11841 VACUUM INFRARED SPECTROMETER FOR THE PROCESS CONTROL OF PETROLEUM PRODUCTS.
A.F.Mal'nyev.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 779-82 (1958). In Ukrainian.

11842 DETERMINATION OF THE INSTRUMENT FUNCTION OF DIFFRACTION GRATING INSTRUMENTS.
M.S.Soskin.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 239-6 (1959). In Ukrainian.
The existing methods of determination are examined. A method is
proposed which differs from those normally used, by the fact that
the photograph of the spectrum in the zero order is taken through a
light filter which cuts out the necessary region of the spectrum. A
detailed analysis of factors affecting the instrument function shows
that this method gives the function directly within the limits of the
errors of measurement. The advantage is that it requires neither a
light source yielding narrow spectral lines, nor a knowledge of the
profiles of the lines employed, as in the methods ordinarily applied.
An experimental determination was made of the instrument function
of a diffraction spectrograph (DFS-3) with plane gratings. The
photographing conditions are described, and data are presented for a
grating with 600 lines/mm, in the region λ = 3100 A at normal slit
width. The resolving power of the spectrograph was determined
under these conditions and proved equal to 63,000. Voigt's functions,
describing the Gauss and dispersion curves and all intermediate
ones, were applied for the approximation of the apparatus function
and the determination of the true profile of the spectral lines. The
instrument function of the DFS-3 is well approximated by a Voigt
curve which is close to the Gauss curve. The true form of the
mercury lines 3125 and 3131.55 A was determined; the necessary
data are presented. The curves of the observed and true form of
these lines are given.

MODULATION OF LIGHT BY MEANS OF AN ELECTRIC FIELD. See Abstr. 11829

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

11843 SYNTHESIS OF MULTIPLE ANTIREFLECTION FILMS OVER A PRESCRIBED FREQUENCY BAND.
L.Young.
J. Opt. Soc. Amer., Vol. 51, No. 9, 967-74 (Sept., 1961).
The synthesis (as opposed to analysis) of multilayer dielectric
films as antireflection coatings over any specified frequency band
has not been attempted before. The similarity with transmission
lines, which can be synthesized as multisection quarter-wave

transformers to minimize reflection over any prescribed frequency band, is utilized by applying recently developed synthesis procedures for quarter-wave transformers to the synthesis of multiple anti-reflection films. [See O.S.Heavens, Optical Properties of Thin Solid Films. New York: Academic Press (1955) and Abstr. 217 of 1952]. A brief review of network synthesis is given, leading up to the synthesis of quarter-wave transformers and multilayer films. Numerical tables are presented in this paper from which anti-reflection coatings of up to four layers can be designed by interpolation. The design procedure (synthesis) described herein leads to the best possible antireflection films, but demands precisely controlled materials with certain refractive indices. It is hoped that this paper will help to promote the development of such materials, and will encourage opticists to try experimentally for the optimum performances possible in theory.

11844 THE ANGULAR VARIATION OF LIGHT SCATTERED BY SINGLE DIOCTYL PHTHALATE AEROSOL DROPLETS. F.T.Gucker and R.L.Rowell.
Disc. Faraday Soc. (GB), No. 30, 185-91 (1960).

The light-scattering diagrams of single aerosol droplets of dioctyl phthalate were determined by charging them, suspending them in an electrostatic field, illuminating them with monochromatic light of wavelenght λ and measuring the light scattered into a photometer moving over the range of 40 to 140° from the direction of illumination. Particle radius r was calculated from rate-of-fall measurements and the Stokes–Cunningham–Millikan equation. Good agreement was obtained with scattering diagrams calculated from the Mie theory, which indeed provide a more sensitive measurement of particle size than do rate-of-fall measurements. Detailed calculations of scattered intensity according to the Mie theory were made at angular intervals of 1° over the range of size parameter $\alpha = (2\pi r/\lambda) = 0{\cdot}1(0{\cdot}1)30{\cdot}0$ for a refractive index of 1·486 and at several values of α for a refractive index of 1·50. The number of maxima in the scattering diagrams increases with α. Graphs of the angular position of the maxima in the two polarized components show that new maxima are formed by splitting where the curves for the two polarized components intersect and the size parameter is approximately divisible by $\pi/4$.

11845 LIGHT-SCATTERING PROPERTIES OF PIGMENT SUSPENSIONS. W.R.Blevin and W.J.Brown.
J. Opt. Soc. Amer., Vol. 51, No. 9, 975-82 (Sept., 1961).

The light-scattering properties of pigment suspensions are discussed in terms of an approximate theory, with special emphasis on the role of the size of the scattering particles and their refractive index relative to the surrounding matrix. Experiments are described which confirm that the theory is a useful basis for understanding the behaviour of pigment suspensions.

LIGHT SCATTERING OF COATED AEROSOLS. See Abstr. 11637

RAYLEIGH SCATTERING OF LIGHT AND ORIENTATIONAL ORDERING OF MOLECULES. See Abstr. 11747

SCATTERING OF LIGHT IN IMPERFECT GASES. See Abstr. 11788

11846 LARGE-APERTURE POLARIZERS AND RETARDATION PLATES FOR USE IN THE FAR ULTRAVIOLET. M.N.McDermott and R.Novick.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1008-10 (Sept., 1961).

The ultraviolet properties of films that have useful polarizing properties at wavelengths as short as 215 mμ are reported. Large-diameter films may be obtained, and the material is not bleached by intense ultraviolet radiation. The use of stretched polyvinyl alcohol and cleaved mica sheets as retardation plates is reviewed.

$KClO_3$ CRYSTALS AS INFRARED REFLECTION FILTERS. See Abstr. 11352

COLORIMETRY . PHOTOGRAPHY

11847 SINE-WAVE RESPONSE TECHNIQUES IN PHOTOGRAPHIC PRINTING. R.L.Lamberts.
J. Opt. Soc. Amer., Vol. 51, No. 9, 982-7 (Sept., 1961).

A single photographic emulsion serves as a linear device when analysis is made in terms of the exposure that the material receives. When sinusoidal patterns are printed, harmonics in terms of the transmittance of the negative are introduced in the print, but the and even harmonics tend to compensate each other so that the o all error tends to be small even though the modulation of the sin soidal pattern may be as large as 60% or 70%. The response fu tion in terms of the exposure of the negative should therefore approximate the product of the sine-wave response functions of two materials and should be little affected by processing conditi Experimentally, these conclusions are found to hold very well w a contact print of good quality is made on positive film, even th as many as three successive printings. It is also found that such cascaded response functions can be used to predict the density d bution across an edge.

11848 APPROXIMATION OF THE SINE-WAVE RESPONSE PHOTOGRAPHIC EMULSIONS. D.P.Paris.
J. Opt. Soc. Amer., Vol. 51, No. 9, 988-91 (Sept., 1961).

In recent years several attempts were made to approximate experimentally determined sine-wave responses of photographic emulsions by a mathematical function. In this paper, curve-fitti techniques, using four types of functions with a single parameter were applied to those sine-wave response curves which did not appreciable adjacency effects. The Bravais-Pearson correlatio coefficients indicated that the $1/(1 + N^2)$-type function, suggested several authors, fits the sine-wave response curves of the teste emulsions best.

INFLUENCE OF ACOUSTIC MICROSTREAMING ON THE PHOTOGRAPHIC DEVELOPMENT PROCESS. See Abstr. 11815

HEAT . RADIATION

11849 A SIMPLE AND CHEAP THERMAL CONDUCTIVITY APPARATUS. D.W.Stops.
J. sci. Instrum. (GB), Vol. 38, No. 5, 221 (May, 1961).

By using electrical conducting paper as the heating element thermal conductivity measurements on insulating materials, and squares of flat aluminium sheet as the cold plates a good ratio o lateral size to thickness is obtained. Consequently, the difficulti associated with "guard rings" are eliminated. It is claimed that with samples 8" × 8" square and not more than $\frac{1}{2}$" thick, the erro are negligible for practical purposes. E.G.Know

11850 INFLUENCE OF AN ELECTRIC FIELD UPON THE HEAT TRANSFER FROM A HOT WIRE TO AN INSULATING LIQUID. P.K.Watson.
Nature (GB), Vol. 189, 563-4 (Feb. 18, 1961).

Paper discusses experiments showing how heat transfer between heated wire and insulating liquid may be enhanced, usin forces exerted on liquid due to dependence of dielectric constant upon temperature. N.C

11851 COMMENTS ON THE MEASUREMENT OF EMITTANCE OF THE GLOBAR RADIATION SOURC J.C.Morris.
J. Opt. Soc. Amer., Vol. 51, No. 7, 798-9 (July, 1961).

A considerable error can be introduced into emissivity measurements by a small difference in temperature between the sample and the black-body used for comparison. An approximat calculation shows that, owing to experimental procedure, publish emissivities of globar between 1 and 15 μ are probably low by 10-20%. Suggestions are made for improved measurements. L.M.Rob

AN APPROXIMATE SOLUTION OF THE HEAT CONDUCTI EQUATION. See Abstr. 11716

MODULATION IN DETECTION OF INFRARED RADIATION See Abstr. 11828

THERMAL SHOCK BEHAVIOUR OF BRITTLE MATERIALS See Abstr. 11172

11852 REFLECTION-REDUCING COATINGS TO IMPROVE THE PERFORMANCE OF SEMICONDUCTOR PHOT DETECTORS. J.R.Jenness, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 7, 798 (July, 1961).

Suggests that a method of Farber et al. (Abstr. 9502 of 1961 had been previously disclosed by the author.

RESPONSE CHARACTERISTICS OF A RADIATION THERMOCOUPLE AT VARIOUS PRESSURES.
McCarthy.
J. Soc. Amer., Vol. 51, No. 7, 801 (July, 1961).
Measurements of relative response and time constant were in air, argon, helium and neon at pressures between and 760 mm Hg. The method is briefly described and the ts tabulated. L.M.Roberts

11854 INTERACTION OF WEAK PRESSURE WAVES WITH THE FLAME FRONT. S.S.Novikov and Yu.S.Ryazantsev.
Akad. Nauk SSSR, Vol. 137, No. 6, 1409-12 (April 21, 1961).
Russian.
The non-relaxational interaction of weak pressure waves with flame front is discussed theoretically allowing for the change ume propagation velocity with change of thermodynamic acteristics of the combustion mixture in the weak waves. A erical example is given for a methane-air mixture. [English slation in: Soviet Physics – Doklady (USA)]. R.F.S.Hearmon

RECOMBINATION OF IONS IN FLAMES. See Abstr. 11914

PROPAGATION OF A ⇌ B → C FLAMES. See Abstr. 11619

11855 SIMPLE BRIDGE FOR THE DIRECT MEASUREMENT OF TEMPERATURE DIFFERENCES.
P.Godin.
Sci. Instrum. (GB), Vol. 38, No. 8, 330-1 (Aug., 1961).
Describes a sensitive thermometer, which measures temperature differences directly. The circuit is a simple Wheatstone ge with thermistors as sensing elements. By choosing the stances in a certain ratio to each other, equal temperature erences give galvanometer currents equal to within 0·6% of other, for an absolute temperature change of 6 deg C.

11856 INTERNAL "DISAPPEARING FILAMENT" FOR MAINTAINING CONSTANT TEMPERATURE IN A VUUM. I.S.Solet.
Sci. Instrum. (USA), Vol. 32, No. 7, 860 (July, 1961).
The temperature of a sample contained in a vacuum chamber controlled by optical comparison with a fine tungsten wire ed with a constant current and mounted in front of the sample in the same enclosure. Viewing with a cathetometer telescope, eatability of 870 ± 4°C was obtained. Advantages arise if thermouples are difficult to fix and sublimated deposits on the walls ld lead to inaccurate measurements with an optical pyrometer onventional design. W.Steckelmacher

11857 PROGRAMMED TEMPERATURE REGULATION.
P.D.Kalinin and A.K.Kuznetsov.
Pribory i Tekh. Eskper (USSR), 1958, No. 1, 136-7 (Jan.-Feb.).
Russian.
A suitable profile cut from bronze, brass or copper, or made n stiff wire was fitted to an EPD recording potentiometer on axis of the pen holder. A silver contact touched the profile and nections were made to a transformer so that when the contact hed the profile a circuit was completed through the coil of a rcury switch; this then completed the circuit through the heater part of it (this gave closer control). When the contact left the file the heater circuit was broken. If there was a time lag in the perature response of the furnace a time delay relay could be rted. With the electronically controlled potentiometer EPP-09 separate contacts were fitted to the pen carriage and these rated on a strip of metal fixed to the chart representing the programme of the temperature control. [English translation in: Instrum. exper. Tech. (USA), No. 1, 152-3 (Jan.-Feb., 1958; publ. Nil, 1959)]. E.H.Dock

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

11858 VAPORIZATION OF GERMANIUM IN TELLURIUM VAPOURS. V.D.Ignatkov and V.E.Kosenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 89-93 (Jan., 1961).
In Russian.
The rate of vaporization of crystalline germanium in tellurium vapours was abnormally high. At 900°C the rate of vaporization rose linearly with increase of the tellurium vapour pressure from 10^{-7} to 1 mm Hg; above the latter pressure the effect reached saturation. The heat of vaporization of germanium in tellurium vapours of 0.6 mm Hg pressure was 12.4 kcal/mole, which was seven times smaller than the heat of vaporization of germanium in vacuum. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 65-8 (July, 1961)]. A.Tybulewicz

11859 VAPORIZATION OF SILICON IN TELLURIUM VAPOURS. V.E.Kosenko and B.A.Nestarenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 660-2 (Feb., 1961).
In Russian.
The rate of vaporization of Si at 1000°C rose monotonically with increase of the Te vapour pressure; at 100 mm Hg pressure of Te the rate of vaporization of Si was 10^6 times greater than in vacuum. The latent heat of vaporization of Si fell with increase of the Te pressure, reaching 13.8 kcal $mole^{-1}$ at 100 mm Hg pressure of Te, which is 7.5 times smaller than the heat of vaporization in vacuum. [English translation in: Soviet Physics – Solid State (USA), Vol. 3, No. 2, 484-5 (Aug., 1961)]. S.Chomet

11860 VAPORIZATION OF ALUMINUM ARSENIDE. M.Hoch and K.S.Hinge.
J. chem. Phys. (USA), Vol. 35, No. 2, 451-3 (Aug., 1961).
Vaporization of aluminium arsenide was studied, using the Knudsen effusion method. Aluminium arsenide decomposes according to the reaction $AlAs_{(s)} \rightarrow Al_{(g)} + \frac{1}{2}As_{2(g)}$. For the reaction $Al_{(s)} + As_{(s)} \rightarrow AlAs_{(s)}$, ΔH_{298} is found to be -35.4 ± 3.1 kcal.

11861 THERMODYNAMIC PROPERTIES OF TRIFLUOROACETONITRILE FROM 12°K TO ITS BOILING POINT. E.L.Pace and R.J.Bobka.
J. chem. Phys. (USA), Vol. 35, No. 2, 454-7 (Aug., 1961).
The saturated heat capacities of trifluoroacetonitrile were measured from 12°K to the normal boiling point 205.47°K. The vapour pressure of the liquid to 1 atm is represented by the equation

$$\log_{10}P_{mm} = -1337.916/T - 4.02312\log_{10}T + 18.69693.$$

The solid–liquid–vapour triple-point temperature is 128.73°K. The heat of fusion at the triple point and the heat of vaporization at the normal boiling point are, respectively, 1187.7 cal/mole and 4262 cal/mole. The experimental value of the entropy of the gas at the normal boiling point, 65.01 ± 0.20 e.u./mole, is in excellent agreement with the theoretical value of 64.96 e.u./mole calculated from spectroscopic and molecular data assuming a symmetrical top molecule.

11862 URANIUM MONOSULFIDE. I. VAPORIZATION, THERMODYNAMICS, AND PHASE BEHAVIOR. E.D.Cater, P.W.Gilles and R.J.Thorn.
J. chem. Phys. (USA), Vol. 35, No. 2, 608-18 (Aug., 1961).
The rate of evaporation of uranium monosulphide was measured over the 900-deg temperature range 1840° to 2730°K and a pressure range 10^{-3} to 10^{-6} atm, with an estimated accuracy of ± 4%, by collection of vapour effusing from tungsten effusion cells containing the solid. The congruently evaporating composition was shown to by S/U = 1.00. The effusion rate is expressed in terms of an "effective" vapour pressure P_E calculated as though the entire vapour consisted of gaseous US molecules. An empirical equation derived by the method of least squares from the data is

$$\log P_E(\text{atm}) = -1.7382 + 3.127\times10^4/T - 1.3181\times10^6/T^2 + 0.093776\times10^{12}/T^3.$$

Mass spectrometric measurements show that the vaporization actually occurs both to gaseous US and to gaseous U + S. The present data are treated to yield the heats of sublimation at 2300°K to gaseous molecules, 150.3 ± 2.1, and to gaseous elements, 271.2 ± 4.0 kcal/mole, where the quoted uncertainties are estimated errors. The corresponding entropies of sublimation are: to molecules, 38.4 ± 0.6, and to atoms, 65.5 ± 1.6 cal/deg mole. The lattice parameter of uranium monosulfide is 5.4903 ± 0.0002 A. The melting point is 2735 + 30 – 5°K. The monosulphide solid phase appears to encompass a small composition range. Values derived from the experimental data and the literature for absolute entropies at 2300°K are 45 ± 2 e.u. for solid, and 83 ± 3 e.u. for gaseous US, where estimated errors are given. The heat of formation of solid US at 298°K from the gaseous atoms is estimated to be -273 ± 5 kcal/mole and from the solid elements, -90 ± 5. The free energies of forma-

tion of solid and gaseous monosulphide between 2100 and 2400°K are expressed by the equations

$$\Delta F_f^0(US,s) = 64.0T - 268000 \text{cal/mole}$$
$$\Delta F_f^0(US,g) = 38.8T - 152000 \text{cal/mole}$$

A semitheoretical treatment gives nonlinear equations for the temperature dependences of the free energies and entropies of vaporization.

11863 URANIUM MONOSULFIDE. II. MASS SPECTROMETRIC STUDY OF ITS VAPORIZATION.

E.D.Cater, E.G.Rauh and R.J.Thorn.
J. chem. Phys. (USA), Vol. 35, No. 2, 619-24 (Aug., 1961).

A study of the vapour effusing from a tungsten effusion cell containing uranium monosulphide was performed with the aid of a time-of-flight mass spectrometer. Between 1700° and 2150°C uranium monosulphide vaporizes predominantly according to the reactions

$$US(s) = US(g), \quad (I)$$

and

$$US(s) = U(g) + S(g), \quad (II)$$

and to a detectable extent at 2100°C and above by the reaction

$$2US(s) = US_2(g) + U(g).$$

Least squares treatment of the ion current ratio I_{US^+}/I_{U^+} as a function of temperature between 1885° and 2130°C yields the relationship $\Delta H_T^0(I) - [\Delta H_T^0(H)/2] = 14.6 \pm 2.4$ kcal/mole, where the error is estimated. In the presence of very small amounts of oxygen in the solid monosulphide the vapour species UO and UOS are found. A faint peak in the spectrum at mass 264 is suspected to have been due to ThS^+.

11864 THERMODYNAMICS OF THE VAPORIZATION OF NICKEL OXIDE.

R.T.Grimley, R.P.Burns and M.G.Inghram.
J. chem. Phys. (USA), Vol. 35, No. 2, 551-4 (Aug., 1961).

A mass spectrometric investigation of the vapour species in equilibrium with nickel oxide showed the vapour phase to consist of Ni, O_2 NiO, and O, whereas the solid phase consists of a NiO solid solution and Ni(s). The dissociation energy of NiO(g) was found to be 86.5 ± 5 kcal/mole.

LOW-TEMPERATURE PHYSICS

11865 A CRYOSTAT FOR USE AT LIQUID HYDROGEN AND HELIUM TEMPERATURES IN NEUTRON DIFFRACTION STUDIES.

V.S.Kogan, B.G.Lazarev, G.S.Zhdanov and R.P.Ozerov.
Kristallografiya (USSR), Vol. 5, No. 2, 320-1 (March-April, 1960). In Russian.

Describes a cryostat in which the coolant vessel is enclosed by another vessel containing liquid nitrogen. The main use is with liquid hydrogen but the use of liquid helium is also possible. The cryostat is fixed to the neutron diffractometer so that their axes coincide. It has been used in studies of the isotopes of hydrogen at 10-12°K. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 297-8 (Sept.-Oct., 1960)]. J.Thewlis

FOUR-SPECIMEN LIQUID-HELIUM CRYOSTAT FOR FLUORESCENCE. See Abstr. 11838

11866 CONCERNING THE FEASIBILITY OF NUCLEAR COOLING WITH PALLADIUM HYDRIDE.

J.J.Fritz, H.J.Maria and J.G.Aston.
J. chem. Phys. (USA), Vol. 34, No. 6, 2185-6 (June, 1961).

Attempts to obtain nuclear cooling of protons in palladium hydride (Pd_2H) were frustrated by energy evolution in the system below 1°K. It is believed that this energy evolution is due to transitions between nuclear spin states of the bound hydrogen in palladium hydride. J.M.Baker

11867 EPOXY RESIN AS A MATERIAL FOR CONSTRUCTING CRYOGENIC APPARATUS.

R.G.Netzel and J.R.Dillinger.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 855 (July, 1961).

Epoxy resin is shown to be a most useful cement and material for constructing experimental apparatus for use below 1°K. It has the advantages of being non-magnetic, vacuum-tight, and require no undue heat during fabrication. P.A.Wa

18868 METAL-TO-GLASS VACUUM SEAL FOR LOW TEMPERATURES.

N.H.Horwitz and H.V.Bohm.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 857-8 (July, 1961).

A demountable metal-to-glass vacuum seal which uses indiu "O" rings, and remains leak-tight when immersed in liquid helium P.A.Wal

11869 MAGNETIC SUSCEPTIBILITY OF MATERIALS COMMONLY USED IN THE CONSTRUCTION OF CRYOGENIC APPARATUS. G.L.Salinger and J.C.Wheatley.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 872-4 (July, 1961).

The magnetic susceptibility of a range of materials common used in the construction of cryogenic apparatus was measured at 4.2 and 1.6°K so as to separate the weakly magnetic from the non-magnetic. The materials covered include dielectrics, metal fibres, sheets and tapes. P.A.Wa

ADIABATIC DEMAGNETIZATION WITH YTTRIUM–RARE EARTH ALLOYS. See Abstr. 11414

MAGNETIC COOLING WITH PARAMAGNETIC METALS. See Abstr. 11415

Liquid and Solid Helium

11870 TAIT COEFFICIENTS AND λ TRANSITION OF HELI I AND II. R.Ginell.
J. chem. Phys. (USA), Vol. 35, No. 2, 473-8 (Aug., 1961).

Helium I and helium II are both found to obey Tait's law. T constant J is constant, within experimental error, with temperat for He I making this substance a fluid of the first kind. Helium a fluid of the second kind inasmuch as J is constant along an isotherm, but J varies with the temperature. The isotherms wh cross the λ transition can be fitted with two straight lines, one f the He I region and one for the He II region. Plots of J, L, and J/L versus temperature are given. While the behaviour of the J L curves is abnormal, apparently the abnormalities are parallel both constants, since the J/L curve is much more regular. The number average degree of association, the number of particles, the volume of holes is calculated along the 2.00°K isotherm. Th is a sudden jump of these quantities at the λ point. In going fro He I to He II the degree of association increases; the number of particles and the volume of holes decreases. Apparently the structural change that occurs is an inversion. In He I the struct is that of a normal liquid like water, where it consists of larger particles joined by defects consisting of holes and smaller parti At the λ point due to the lowering of the pressure the defect "continuum" becomes tenuous due to the increase in the volume holes, and the bonds suddenly break. The skeleton of the struct of He II then becomes one of the large particles forming a loose network with the remains of the small particles which formerly formed the "continuum" occupying the free space in the network These small particles are then the superfluid component of He I

11871 THERMAL CONDUCTIVITY OF LIQUID He^3. A.C.Anderson, G.L.Salinger and J.C.Wheatley.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 443-6 (May 1, 1961).

The thermal conductivity was measured in the temperature range 0.026°-0.2°K at pressures near 10 cm Hg. Below 0.04°K t conductivity can be expressed by $k = (48/T)$ ergs cm^{-1} sec^{-1}. At 0.2°K, $k = 6.5 \times 10^2$ erg cm^{-1} sec^{-1} $(deg K)^{-1}$, in agreement with extrapolation of the conductivity as measured by Lee and Fairba (Abstr. 3701 of 1960) at 0.24°K and above. H.Lo

11872 POSSIBILITY OF EXCHANGE MAGNETOSTRICTION YIELDING NEGATIVE THERMAL EXPANSION IN SOLID He^3. D.S.Rodbell.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 1-3 (July 1, 1961).

This note points out how the existence of (a) an antiferroma netic exchange interaction dependent upon interatomic separatio and (b) a highly compressible lattice are sufficient conditions to give rise to negative thermal expansion behaviour. Thus the relevant properties of solid He^3 in a certain part of its phase diagram are correlated without the use of a detailed spin-wave calculation. O.Pen

LATTICE DISTORTION DUE TO ISOTOPES IN SOLID HELIUM.
bstr. 11198

perconductivity

11873 THE THEORY OF SUPERCONDUCTIVITY IN THE TAMM–DANCOFF APPROXIMATION. B.P.Nigam.
r. theor. Phys. (Japan), Vol. 25, No. 3, 436-40 (March, 1961).
The Tamm–Dancoff approximation (Abstr. 6264 of 1950) is ed to the interaction Hamiltonian used by Bogolyubov (1958) in heory of superconductivity. It is shown that (1) the require- that there is no virtual production of a single pair of electron ole without phonons, or (2) the electron–phonon coupling meter tends to zero, leads to essentially the same compensating tion as obtained by Bogoyubov.

11874 THE GREEN'S FUNCTION METHOD AND SUPERCONDUCTIVITY OF SYSTEMS OF FERMIONS.
wicki.
. Phys. (USA), Vol. 13, No. 2, 237-49 (May, 1961).
The method of Green's functions in the theory of many-fermion ems has been recently developed by Gorkov and Migdal for the of superconducting systems. Some further applications of r formalism are given both for zero and for finite temperatures. pair distribution function of a superconducting system of nions is calculated by this method. The perturbation theory for urities in superconductors described by one-particle operators urther discussed. The problem of residual two-body forces in perconducting system is discussed. A reaction matrix-type itment of such forces corresponding to a "ladder approximation" turbation theory is indicated.

11875 ON THE SUPERCONDUCTING GROUND STATE. Z.Mikura.
Phys. Soc. Japan, Vol. 15, No. 10, 1783-1806 (Oct., 1960).
The energy difference ΔE between the superconducting and rmal states is recalculated as a function of half an energy gap manipulating the unrenormalized Hamiltonian of Fröhlich by method of Bogoliubov (Abstr. 7034 of 1958). The result is in agreement with experiment, in contrast to Bogoliubov's. Exten- n to higher orders of perturbation calculation does not remove discrepancy. It is then shown that the agreement with experi- nt is recovered if the theory is reformulated on the principle minimum energy in place of the principle of compensation of ngerous diagrams. The screened Coulomb repulsions between ctrons do not change the qualitative aspect of the result. No tailed discussion is offered on the electromagnetic properties, it is suggested that a successful theory in predicting a correct E-μ_0 relation would not necessarily lead to a full understanding them.

11876 EFFECT OF THE SCATTERING OF CONDUCTION ELECTRONS BY THE SPIN WAVES OF A FERROGNETIC ON THE TEMPERATURE OF TRANSITION TO THE PERCONDUCTING STATE. B.V.Karpenko.
. Metallov i Metallovedenie (USSR), Vol. 10, No. 5, 794-6 v.,1960). In Russian.
The question of the effect of the inelastic scattering of the duction electrons by the spin waves of a ferromagnetic on the earance of superconductivity is studied. A certain Hamiltonian d by Vonsovsky and Turov (see Abstr. 10634 of 1954) is simplified retaining only the terms due to inelastic scattering. The miltonian is then transformed by a substitution due to Bogolyubov e Abstr. 8158 of 1959), and this leads to the calculation of the rgy gap between the superconducting and the normal states. The ult is in agreement with the conclusions of Kasuya (see Abstr. 39 of 1959). N.Davy

11877 SUPERCONDUCTIVITY IN THE In–Sn SYSTEM. J.H.Wernick and B.T.Matthias.
hem. Phys. (USA), Vol. 34, No. 6, 2194-5 (June, 1961).
The variation of T_C with composition was measured. The ximum T_C (7.30°K) occurs for the β alloy $In_{0.7}Sn_{0.3}$. M.A.Taylor

11878 SUPERCONDUCTIVITY AT HIGH MAGNETIC FIELDS AND CURRENT DENSITIES IN SOME Nb–Zr ALLOYS.
.Berlincourt, R.R.Hake and D.H.Leslie.
s. Rev. Letters (USA), Vol. 6, No. 12, 671-4 (June 15, 1961).
Wires about 0.1–0.2 mm square containing 25% Zr remain erconducting at 4.2°K. in a transverse field H of 30 kG, up to a current density J_C of 2×10^3 A cm^{-2}. Severe cold-work during preparation increases J_C to 10^6 A cm^{-2}. Cold-rolling produces marked anisotropy of J_C. Wires containing 12% Zr show a peak in the $J_C(H)$ curve at about 25 kG. R.G.Chambers

11879 SUPERCONDUCTING CRITICAL FIELD OF TANTALUM AS A FUNCTION OF TEMPERATURE AND PRESSURE.
C.H.Hinrichs and C.A.Swenson.
Phys. Rev. (USA), Vol. 123, No. 4, 1106-14 (Aug. 15, 1961).
The results of precise critical field measurements on tantalum samples which show "soft" superconducting behaviour are given along with direct measurements of the pressure effect, $(\partial H_C/\partial P)_T$, as a function of temperature. The Bardeen–Cooper–Schrieffer theory is used as a guide in the extrapolation of these data to absolute zero from 1.1°K. The advantages of using an H^2 versus T^2 representation for both the critical-field and pressure-effect data are discussed, and it is shown that if both sets of data can be represented in terms of power series [H^2 or $(\partial H_C^2/\partial P)_T$ versus T^2] over a limited range of temperature, it is then possible to write down explicit power series expressions for the differences in the thermodynamic functions between the normal and superconducting states over this same temperature range. The electronic contributions to the specific heats and the thermal expansions for tantalum are calculated from the experimental data.

11880 SUPERCONDUCTIVITY OF α- AND β-MERCURY. J.E.Schirber and C.A.Swenson.
Phys. Rev. (USA), Vol. 123, No. 4, 1115-22 (Aug. 15, 1961).
Precise critical field measurements and a direct measurement of $(\partial H/\partial P)_T$ as a function of temperature were made on physically identical samples of α- and β-Hg. The purpose of these measurements was to obtain data on the effects of crystal structure on the properties of superconductors, and to permit calculation of various thermodynamic quantities difficult to obtain in any other way. The critical fields of the two phases were found to be identical when expressed in terms of the reduced variables H/H_0 and T/T_C. No generalizations of this type could be found to explain the pressure effects. The advantages of an H^2 versus T^2 and $(\partial H^2/\partial P)$ versus T^2 analysis for extrapolation to absolute zero are stressed. The critical fields of several representative superconductors are compared with the critical field predicted by the Bardeen–Cooper–Schrieffer theory, using a plot that emphasizes the detailed shape of the curves at low temperatures. This plot also can be interpreted in terms of the θ/T_C dependence of the width of the energy gap. The agreement between calorimetric and critical field determinations of the electronic specific heat in the normal state is shown to be improved by using the H^2–T^2 extrapolation. The volume dependence of the reduced energy gap is shown to be very small for those superconductors for which pressure effect data are available.

11881 SUPERCONDUCTIVITY OF TECHNETIUM ALLOYS AND COMPOUNDS.
V.B.Compton, E.Corenzwit, J.P.Maita, B.T.Matthias and F.J.Morin.
Phys. Rev. (USA), Vol. 123, No. 5, 1567-8 (Sept. 1, 1961).
The superconducting transition temperatures of Mo–Tc alloys are reported. Critical field measurements of a 50 at.% alloy indicate that it might be a promising material for superconducting magnets. The similarity of Tc and Re with respect to alloy and intermetallic compound formation is noted. The superconducting transition temperatures of the compounds $ZrTc_6$ and $NbTc_3$ are 9.7° and 10.5°K, respectively. X-ray diffraction data suggest that these compounds have the α-Mn type structure.

11882 SUPERCONDUCTING SOLID SOLUTION ALLOYS OF THE TRANSITION ELEMENTS.
J.K.Hulm and R.D.Blaugher.
Phys. Rev. (USA), Vol. 123, No. 5, 1569-80 (Sept. 1, 1961).
The solid solution alloys formed by the incomplete d-shell metals in groups 4, 5, 6 and 7 were tested for superconductivity down to 1°K. For alloys formed between neighbouring elements in a given row of the periodic table, two transition temperature maxima were observed with valence numbers approximately equal to 4.7 and 6.4, respectively, the only exception being the first long period, in which the upper maximum is absent. Similar maxima occur when the constituent elements are selected from different rows of the periodic table, thus confirming the dominant role of the d-shell electrons. It is known that the normal density-of-states function, $N(0)$, passes through a series of maxima as the d-shell is filled up two of these peaks lying at about the same composition as the two transition temperature peaks observed in the present work. The

relationship of T_c to N(0) for the transition metal alloys is discussed. Transition temperature data are also presented for alloys composed of neighbouring elements in a given column of the periodic table. In this case, the form of the relationship between T_c and electronic or lattice properties is still obscure.

11883 THERMODYNAMICS OF DIRTY SUPERCONDUCTORS. D.J.Kenworthy and D. ter Haar.
Phys. Rev. (USA), Vol. 123, No. 4, 1181-7 (Aug. 15, 1961).

A method due to Tsekhmistrenko (Abstr. 9873 of 1960) is used to eliminate from the Fröhlich Hamiltonian the electron–phonon interaction term. The thermodynamic properties of a super conductor described by this Hamiltonian are then evaluated, using a formalism developed by Zubarev and Tserkovnikov (Abstr. 8164 of 1959) which is based on a paper by Bloch and De Dominicis (Abstr. 7701 of 1958). An extra term is introduced in the Hamiltonian to take the impurity scattering into account and study the effect of this extra term on the transition temperature. For the product of the mean free path and the relative change in the transition temperature values of 7×10^{-6}, 9×10^{-6}, and 8×10^{-6} cm are found for Sn, In, and Al.

11884 VARIATION OF THE ELASTIC MODULI AT THE SUPERCONDUCTING TRANSITION.
G.A.Alers and D.L.Waldorf.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 677-9 (June 15, 1961).

The three elastic moduli of Pb, V and Nb were measured ultrasonically as a function of temperature in both normal and superconducting states. It is shown that the change in zero-point energy between the two states has a negligible effect on the Debye θ. In Pb, but not in V or Nb, the change in bulk modulus agrees well with that derived thermodynamically from the variation of critical field with pressure. R.G.Chambers

11885 FIRST AND SECOND ORDER STRESS EFFECTS ON SUPERCONDUCTING TRANSITIONS IN Ta AND Sn.
D.P.Seraphim and P.M.Marcus.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 680-2 (June 15, 1961).

Measurements are reported on the change in critical field of single crystals of Ta at tensile stresses up to 6000 atm, and on Sn at stresses up to 200 atm. A first-order shear effect is also shown to occur in Sn. R.G.Chambers

11886 SUPERCONDUCTING CHARACTERISTICS OF SUPERIMPOSED METAL FILMS.
P.H.Smith, S.Shapiro, J.L.Miles and J.Nicol.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 686-8 (June 15, 1961).

Current transitions were studied using Pb films about 500 A thick, evaporated on to bare glass or on two Ag films 00-2000 A thick, or between two Ag films each 3500 A thick. Increasing thickness of Ag produced a progressive decrease in both critical current and critical temperature of the Pb. The results are unlikely to be due to impurities, strain, diffusion or alloying. It is claimed that the Ag itself becomes superconducting: persistent currents were induced in a circuit containing a Pb–Ag–Pb sandwich, and in tunnel effect experiments on a Pb–dielectric–Ag–Pb sandwich, an energy gap was observed. R.G.Chambers

11887 SUPERCONDUCTIVITY IN THE NEIGHBORHOOD OF METALLIC CONTACTS. L.N.Cooper.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 689-90 (June 15, 1961).

A simple theoretical discussion of the results reported in the preceding abstract. R.G.Chambers

11888 DIRECT EXPERIMENTAL MEASUREMENT OF THE MAGNETIC FIELD DEPENDENCE OF THE SUPERCONDUCTING ENERGY GAP OF ALUMINUM. D.H.Douglass, Jr.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 14-16 (July 1, 1961).

The energy gap, measured by the tunnel effect method, fell smoothly to zero as the longitudinal field was increased to the critical value H_c, for Al films of thickness 3000 A or less. In a film 4000 A thick, the gap fell only slightly up to $H \sim 0.98\ H_c$ and then fell abruptly to zero. The results agree rather well with the author's predictions (Abstr. 8282 of 1961). R.G.Chambers

SPECIFIC HEAT OF SUPERCONDUCTING INDIUM AND TIN. See Abstr. 11162

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

11889 NEW MODIFIED CAMPBELL'S BRIDGE. K.Hasebe.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 352-3 (March, 1961).

The bridge is balanced by use of a mutual inductance with th coils, i.e. a three-coil transformer, and the starting circuit of a discharge lamp is given as an example of application. At the moment voltage is applied, the bridge is unbalanced, and the fila current is high enough to start the lamp. The bridge is designed balance when the lamp discharge current attains the normal oper ing value. C.F.Piz

CIRCUIT FOR THE MEASUREMENT OF SMALL DISPLACEMENTS BY ELECTRICAL SCREENING. See Abstr. 11732

11890 A SYSTEM FOR RECORDING AND INTEGRATING PHYSICAL MEASUREMENTS. N.E.Rider.
Austral. J. Phys., Vol. 13, No. 4, 742-9 (Dec., 1960).

A new type of multi-channel recorder is described. The inp from each channel is used to deflect a mirror galvanometer, and the magnitude of the deflection is recorded by an electromagneti counter. The result is achieved by replacing the usual scale by long selenium photo-cell covered by a grid of alternate opaque a transparent bands; the pulses produced when the light beam reflected from the galvanometer mirror moves over the grid are amplified and counted. Arrangements are made to correct this count for any change in the galvanometer zero. J.L.Red

11891 ELECTRONIC CIRCUITS OF THE BR-1 TIME-OF-FLIGHT SPECTROMETER.
H.Ceulemans, A.de Keyser and E.Mies.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 297-304. In French.

Neutrons from the reactor are passed through a rotating obturator consisting of laminations of Cd and Al. The neutrons having energies less than that required to pass through Cd (0.4 e can only pass through the obturator when the laminations are par to the path of the neutrons and thus appear in short bursts. time distribution of the arrival of these bursts at the detector corresponds to the time of flight. Neutrons are counted in a num of gated channels, each open for a time δt, the first being opened a time t after a signal T_0 which is provided by a mirror carrie the obturator shaft and illuminated by a light source. The timing processes are controlled by a secondary frequency standard (pul generator), at 2 Mc/s. This frequency is divided by 20 after the oscillator pulses have passed through the first gate, which is ope by the signal at T_0. This method reduces the error arising from random phase difference T_0 and the oscillator. The divider cons of a binary stage and a trochotron in cascade. Its output is pass to a variable delay circuit consisting of two trochotrons in casca The divider fixes the time δt, which can be set between 10 and 20 while the variable delay fixes the time t, after which a second g is opened and passes the pulses from the divider, a trochotron chronometer. This advances in steps of δt and opens all channel turn. W.G.St

11892 ARGONNE THREE DIMENSIONAL ANALYZER. J.P.McMahon.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 308-9.

Three inputs representing parameters can be handled, usual with two amplitude-digital convertors and one time-digital convertor. The address scaler for each convertor has 8 binary stages, giving 256 channels for each convertor. This is equivale to an analyser with 16 777 216 channels. If the parameters meet certain externally imposed requirements, the addresses are written in a magnetic tape store. For analysing, the tape is removed and placed on a reading transport and the selected outputs are placed in a magnetic core memory. The information in the memory can be converted to a form suitable for computer input. W.G.Str

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

11893 DEFINITION OF MACROSCOPIC ELECTROSTATIC FIELD. A.N.Kaufman.
ner. J. Phys., Vol. 29, No. 9, 626-30 (Sept., 1961).
It is frequently stated that the electric field of the macroscopic well equations is the mean of that of the microscopic Maxwell ations. By "mean" is meant either a volume average or a istical average, the result being the same. In this paper, the trostatic field is considered, and it is shown that the mean roscopic field is not appropriate for use in the concept of ectric constant. A suitable definition of macroscopic field is ussed, and it is shown that it differs from the mean microscopic d in a nonuniform medium.

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

11894 GENERATION OF ELECTRICITY WITHOUT THE USE OF ROTATING MACHINERY. K.H.Spring.
ture (GB), Vol. 190, 297-9 (April 22, 1961).
General review of those methods currently under investigation luding the fuel cell, magnetohydrodynamic generation, thermionic neration, thermoelectricity, thermomagnetic generation, ferro-ctric generation, solar cells, and piezoelectric converters.
C.A.Hogarth

11895 A CONTRIBUTION TO THE PROBLEM OF DECIDING ON THE VALIDITY OF A PRINCIPLE OF EXTREME NERGY DISSIPATION FOR CURRENT FLOW IN A CONDUCTOR.
H.Kischel and J.Wilhelm.
itr. Plasma Physik (Germany), Vol. 1, No. 1, 11-29 (1960-61).
German.
After a careful examination, it is concluded that the formulation such a principle requires considerable knowledge of the character-ics of the conductor. In particular, one needs to specify care-ly exactly what is being held constant, and the extreme values n be changed from maxima to minima by giving the resistance of e conductor a rising or falling characteristic.
H.N.V.Temperley

11896 ON THE CALCULATION OF THE PROPAGATION OF AN ALTERNATING CURRENT ON THE SURFACE OF BODY OF REVOLUTION IN THE PRESENCE OF A STRONG IN EFFECT. G.A.Shneerson.
. tekh. Fiz. (USSR), Vol. 31, No. 1, 51-4 (Jan., 1961). In Russian.
For abstract, see Abstr. 9523 of 1961. [English translation Soviet Physics – Technical Physics (USA), Vol. 6, No. 1, -7 (July, 1961)].

11897 CURRENT WAVES IN A THIN CYLINDRICAL CONDUCTOR. III. VARIATIONAL METHOD AND ITS PPLICATION TO THE THEORY OF IDEAL CONDUCTORS AND F CONDUCTORS WITH IMPEDANCE. L.A.Vainshtein.
. tekh. Fiz. (USSR), Vol. 31, No. 1, 29-44 (Jan., 1961). In Russian.
For abstract, see Abstr. 5583 of 1961. [English translation Soviet Physics – Technical Physics (USA), Vol. 6, No. 1, 19-29 ly, 1961)].

11898 CURRENT WAVES IN A THIN CYLINDRICAL CONDUCTOR. IV. AERIAL INPUT IMPEDANCE AND THE CURACY OF FORMULAE. L.A.Vainshtein.
. tekh. Fiz. (USSR), Vol. 31, No. 1, 45-50 (Jan., 1961). In Russian.
For abstract, see Abstr. 5584 of 1961. [English translation Soviet Physics – Technical Physics (USA), Vol. 6, No. 1, 30-3 ly, 1961)].

11899 LONDON SYMPOSIUM ON ELECTRICAL CONTACTS. M.R.Hopkins.
Brit. J. appl. Phys., Vol. 12, No. 7, 313-17 (July, 1961).
The symposium was held by The Institute of Physics and The Physical Society, in collaboration with The Institution of Electrical Engineers on the 5th, 6th and 7th April, 1961, at Brunel College of Technology. Sessions were devoted to "Principles", "Fundamental investigations and techniques", "Contact surfaces", "Materials and design", "Non-metallic contacts" and "Miscellaneous subjects". At each of these sessions, four or five short papers were presented and followed by discussion.

11900 THE PHYSICS OF ELECTRICAL CONTACT PHENOMENA. F.Llewellyn Jones.
Brit. J. apply. Phys., Vol. 12, No. 7, 318-22 (July, 1961).
An outline is given of the nature of the fundamental physics processes occurring at an electrical contact and the problems to which they give rise, particularly in relation to light duty electrical contacts. The discussion includes contacts in which currents and potentials are of the order of amperes and volts, and also the so-called electrostatic contacts, in which one or other or both of these quantities may be extremely small. Recent work on microscopic molten metal bridges, micro-arcs (both of which are important in metal transfer) and the problems of "electrostatic" contacts which mainly depend on surface properties, are described. Outstanding problems are discussed and the method by which they are being attacked are indicated.

11901 THERMOELECTRIC MEASUREMENTS AT SMALL-AREA CONTACTS. M.Cutler.
J. appl. Phys. (USA), Vol. 32, No. 6, 1075-82 (June, 1961).
Measurement of the effects of heating a substance in the vicinity of a metal contact by means of an electrical current leads to the determination of various combinations of the thermoelectric parameters sufficient to determine the electrical conductivity, the thermal conductivity, and the Seebeck coefficient. If the metal contact is small, radiation causes negligible error in the determination of the thermal conductivity. One of the combinations obtained directly is the thermoelectric figure of merit. Equations are derived which relate to the heating current an observed thermoelectric voltage or change in resistance caused by a change in temperature at a small area contact. Geometric factors are found to cancel out of these equations. Quantitative relations are also presented which set limits on the effects of radiation. An experimental method is described which was used for making such measurements, and some experimental results are reported which permit comparison to conventional measurements in accuracy. Ways in which measurements of thermal diffusivity can be combined with the other measurements are also discussed.

11902 ZERO-, FIRST-, AND SECOND-ORDER THEORIES OF A GENERAL THERMOCOUPLE. A.H.Boerdijk.
J. appl. Phys. (USA), Vol. 32, No. 8, 1584-9 (Aug., 1961).
The thermocouple to be dealt with has two bars of arbitrary shape. Each of the properties of the materials (the thermal resistivity κ, the electrical resistivity ρ, and the Seebeck coefficient s) is represented by a finite number of terms of a MacLaurin series in T (the temperature) and u (a position coordinate). A method is described to obtain a theory of arbitrary order t. Such a theory is based on a solution $T = f(u)$ which satisfies the basic nonlinear differential equation (obtained by application of thermodynamics of irreversible process) and the boundary conditions if all terms of order $> t$ are neglected. The order of a term is equal to the sum of the orders of all partial differential quotients of κ, ρ, and S with respect to T and u occurring in that term. The method is applied to obtain the electrical output power and the thermal output powers as functions of the electrical current and the temperatures of the junctions in theories of order zero, one, and two. The zero-order theory is identical with the common theory of thermocouples with constant properties κ, ρ, and S. In the first-order theory an expression is obtained for the efficiency for production of cold. This efficiency can be improved by suitable temperature dependence of S and by suitable place dependence of S. Finally the accuracy of approximation is discussed.

11903 ON PROPOSED SEMICONDUCTOR THERMOBATTERIES FOR REFRIGERATORS. V.A.Naer and S.A.Rozhentseva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1125-31 (April, 1961).
In Russian.
Account is taken of the temperature differences between the warm junctions and the surroundings and between the cold junctions

and the space to be cooled. Curves are given for these temperatures, the production of cold and the coefficient of performance as functions of the current, for a domestic semiconductor refrigerator. [English translation in: Soviet Physics — Solid State (USA)].
R.Berman

11904 POWER APPLICATIONS OF THERMOELECTRIC DEVICES. A.F.Ioffe, B.Ya.Moizhes and L.S.Stil'bans.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2834-57 (Nov., 1960). In Russian.

A comprehensive review by the leading workers in the field. Deals with theoretical and practical aspects of thermoelectric devices such as generators, refrigerators, heat pumps, thermostats and air conditioners. Discusses solid, thermionic and plasma devices. [English translation in: Soviet Physics—Solid State (USA)].
A.Tybulewicz

11905 THE INFLUENCE OF A MAGNETIC FIELD ON THE MOTION OF PARTICLES IN SOLUTIONS OF ELECTROLYTES.
V.A.Myamlin, V.A.Kibardin and Yu.Ya.Gurevich.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 6, 1405-8 (April 21, 1961). In Russian.

This paper deals with the motion of liquid and solid spherical droplets in a viscous liquid in perpendicular electric and magnetic fields. Both charged and uncharged droplets are considered, and the steady-state ("magnetophoretic") particle velocity is deduced in each case by calculating the velocity distribution within and just outside the drop. Several possible applications of these results are mentioned.
O.Penrose

IONIZATION

11906 DOUBLE AND TRIPLE IONIZATION IN MOLECULES INDUCED BY ELECTRON IMPACT.
F.H.Dorman and J.D.Morrison.
J. chem. Phys. (USA), Vol. 35, No. 2, 375-81 (Aug., 1961).

Double and triple ionization by electron impact in molecules is examined and, as was found for the monatomic gases, the data support the view that the threshold law for the probability of double ionization is a square-law function of the excess electron energy. Some excited states were detected, and autoionization does not seem to be important. The vertical potentials for all the processes of multiple ionization observed were measured. The relative electronic-transition probabilities for single, double, and triple ionization are compared. The factors affecting the stability of multiply charged molecular ions are discussed, and an attempt is made to correlate the electron impact data with the molecular structures. It is shown that Coulomb repulsion between the separated charges causes the potential energy functions describing these ions to be of unusual form.

11907 THE PHOTOIONIZATION OF H_2 AND THE SPATIAL CORRELATION BETWEEN ELECTRONS. M.Shimizu.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1440-8 (Aug., 1960).

The photoionization of H_2 by photons of sufficiently short wavelength produces the molecular ion H_2^+ as well as the atomic ion H^+. The relative yield H^+/H_2^+ is calculated as the function of energies of photons. The description of the ground state of H_2 is given by the super-position of two configurations: $\sigma_g^2 + \lambda\sigma_u^2$, taking account of the spatial correlation between electrons, while those of H_2^+ is given by the linear combinations of Wang type atomic orbitals. The results show that the relative yield curve has a plateau in the high-energy range and its height is essentially proportional to λ^2. The various approximations used in the calculation (Franck–Condon approximation, Born approximation, dipole velocity approximation, the neglect of possibility of production of H_2^+ and H^+ through autoionization and multiple ionization etc.) are discussed. The velocity distribution of the ejected protons is also calculated according to the Franck–Condon principle.

11908 PRE-BREAKDOWN IONIZATION IN HYDROGEN AT LOW PRESSURES. S.C.Haydon and A.G.Robertson.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 92-102 (July, 1961).

Detailed studies of pre-breakdown ionization in hydrogen gas at low pressures were made in the presence of uniform electric fields and appropriate analytical methods and experimental procedures suitable for similar studies in crossed electric and magnetic fies were established. The factors influencing determinations of the first Townsend ionization coefficient α/p_0 from pre-breakdown ionization measurements are discussed and an observed pressu dependence of α/p_0 at $E/p_0 = 350$ is shown to be due to the prese of vapour impurities which can give rise to the large values of o recently reported. Values of α/p_0 were measured for the range values of E/p_0 from 50 to 450 V cm^{-1} (mm Hg)$^{-1}$.

11909 ANOMALIES IN IONIZATION COEFFICIENTS AND I UNIFORM FIELD BREAKDOWN IN ARGON FOR LO VALUES OF E/p. D.E.Golden and L.H.Fisher.
Phys. Rev. (USA), Vol. 123, No. 4, 1079-86 (Aug. 15, 1961).

Pre-breakdown ionization currents in argon were measured in uniform fields for low values of the ratio of field strength to pressure E/p [5 to 12 V cm^{-1} (mm Hg)$^{-1}$]. Currents obtained wi varying electrode separation d at constant E/p and constant p cou not be analysed to yield values of the Townsend coefficients α/p and γ. Currents obtained with varying p at constant E/p and constant d could be analysed to yield values of α/p and γ, but suc currents yielded coefficients which depend on d. The dependence of the values of α/p on d is attributed to the production of highly excited atoms by resonance radiation at some distance from the positions where the electrons lose their energy; these highly excited atoms then produce molecular ions and electrons in collisions with ground-state argon atoms. The secondary mechanism and the dependence of γ on d are associated with resonance radiation. Sparking potential measurements in argon made by varying both p and d for values of pd corresponding to breakdown for the above range of E/p show deviations from Paschen's law. Disregarding the above anomalies, the values of α/p are smaller than the earlier measurements of Kruithof and Penning (1936) by as much as a factor of 15 at E/p = 5 (d = 4 cm). At this value of E/p (and of d), the value of $\exp(\alpha d)$ at breakdown is only 1.05, and the value of γ is about 20. At larger values of E/p, the present value of α/p become independent of d and approach theirs. The sparkin potentials obtained are significantly larger than those obtained by Kachickas and Fisher (Abstr. 7694 of 1953). This is shown to be to the condition of the cathode surface.

IONIZATION OF ARGON IN A SHOCK TUBE. See Abstr. 11780

11910 MONTE CARLO CALCULATIONS OF MOTION OF ELECTRONS IN HELIUM. T.Itoh and T.Musha.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1675-80 (Sept., 1960).

Monte Carlo calculations were performed with an electronic computor to investigate the behaviour of electrons in helium gas a uniform electric field. The ionization and excitation coefficien and the drift velocities of electrons in helium for $E/p_0 = 40$, 80 a 160 V/cm^{-1} mm^{-1} Hg were obtained. The velocity distributions of electrons were also calculated.

11911 COMPARISON OF TWO THEORETICAL APPROACH TO ELECTRON BEHAVIOR IN A–CO_2, A–N_2, A–H_2, AND A–CO GAS MIXTURES. M.A.Uman.
Phys. Rev. (USA), Vol. 123, No. 2, 399-403 (July 15, 1961).

The electron drift velocity and electron average energy for l energy electrons in binary gas mixtures of A–CO_2, A–N_2, A–H_2, A–CO are determined using two theoretical methods of approach (1) a "distribution function" or "Boltzmann equation" approach; a (2) an "average electron" approach. The results of the two theor methods of approach are compared and discussed.

11912 THE RATE OF DEIONIZATION OF RAREFIED HELI IN A MAGNETIC FIELD. I.
A.S.Sȳrgii and V.L.Granovskii.
Radiotekhnika i Elektronika (USSR), Vol. 4, No. 11, 1854-60 (Nov., 1959). In Russian.

An investigation was made to find the influence of a magnetic field on the rate of deionization and the rate of electron and ion diffusion in a helium plasma. A probe method was used to measu the deionization time constant and the transverse ambipolar diffusion coefficient as functions of magnetic field in the range from zero to 1500 G. The results show that the deionization time constants increase with increase in magnetic field but more slow than predicted by theory. The dependence of the deionization rat on pressure agrees qualitatively with the results of diffusion theo for pair collisions, but the dependence of the transverse ambipol diffusion coefficient on magnetic field does not agree with Townsend's formula.
R.C.Gl

913 THERMAL IONIZATION AND ELECTRICAL CONDUCTIVITY IN MIXTURES OF GASES. Yu.V.Sanochkin.
kh. Fiz. (USSR), Vol. 31, No. 2, 188-93 (Feb., 1961). In
an.
or abstract, see Abstr. 5421 of 1961. [English translation
oviet Physics—Technical Physics (USA), Vol. 6, No. 2, 134-7
, 1961)].

914 RECOMBINATION OF IONS IN FLAMES. EFFECT OF TEMPERATURE. I.R.King.
m. Phys. (USA), Vol. 35, No. 1, 380-1 (July, 1961).
probe method was used to measure the recombination rate
opane flames between 1600° and 2000°K. Values around
10^{-7} cm³/sec, increase slightly with temperature. The
nbination processes are discussed. A.G.Gaydon

RECOMBINATION IN A HELIUM PLASMA. See Abstr. 11924

1915 CHARGE EXCHANGE BETWEEN CAESIUM IONS AND ATOMS. R.M.Kushnir.
yin. fiz. Zh. (USSR), Vol. 3, No. 6, 788-95 (1958). In Ukrainian.
Measurements were made of the charge exchange cross-
ions in the ion energy range 6-656 eV by the retarding field
iod and the method of slow ion extraction. To eliminate the
ience of secondary electron emission from the electrodes on
results of the measurements, a weak (H ~ 30 Oe) magnetic field
applied perpendicular to the ion beam. The same method was
to measure the cross-sections of charge exchange between
ssium ions and atoms. A comparison of the results obtained
published theoretical values shows that the best agreement is
the data of Firsov (Abstr. 5261 of 1952). The experimental
ies of the cross-sections for caesium are greater than the
responding values obtained for potassium which agrees with the
ory.

ELECTRIC DISCHARGES

ON THE THEORY OF CORONA DISCHARGE IN NUCLEAR DIATION COUNTERS. See Abstr. 10804

11916 ELECTRONIC AND IONIC CURRENT AT THE CATHODE OF A HOLLOW-CATHODE DISCHARGE. V.K.Rohatgi.
appl. Phys. (USA), Vol. 32, No. 6, 1173-4 (June, 1961).
Expressions are given for the field at the cathode and fraction the current carried by electrons in a space charge limited llow cathode discharge. The positive ion current is estimated as % of the total current and with a value of 0.1 for γ, the coefficient secondary emission by ion bombardment, the cathode emission e to this effect is only 2%. Calculated values of field at the thode with observed current densities give fields of 4.5×10^5 V/m, value insufficient to cause field emission. It is concluded that oto-electric cathode emission is responsible for 75-80% of the al current. H.Edels

11917 EXPERIMENTAL STUDY OF ARC STABILITY. II. AN INVESTIGATION OF MERCURY ARC STABILITY.
A.Farrall and G.H.Reiling.
appl. Phys. (USA), Vol. 32, No. 8, 1528-34 (Aug., 1961).
The duration of an arc struck on a mercury pool was studied der a variety of arc currents and vapour pressures. It is shown at at temperatures greater than −38°C the distribution of arc etimes follows an exponential decay law over the entire current nge studied, whereas a distinct departure from this distribution curs between −57° and −195°C. Over the current range 02-2.0 A the mean arc lifetime varies from a few microseconds 0.1 sec on a mercury cathode at 23.5°C. This study extends evious work and establishes that there is a sudden change in arc bility at the melting point. The data demonstrate, contrary to perience with liquid mercury, that an arc can be struck for very w currents in the case of solid mercury and, once struck, will rn for a finite length of time given by $\tau = \tau_0 + KI$, where τ_0 is a sidual lifetime for almost zero current. It is shown, however, at as the current is reduced, the probability of drawing an arc comes diminishingly small.

TOROIDAL HIGH-PRESSURE DISCHARGE EXPERIMENT. See Abstr. 11945

11918 NANOSECOND TRIGGERING OF AIR GAPS WITH INTENSE ULTRAVIOLET LIGHT. T.F.Godlove.
J. appl. Phys. (USA), Vol. 32, No. 8, 1589-96 (Aug., 1961).
Measurements are presented of the breakdown time of a conventional two-electrode air gap. The applied voltage is maintained below the sparking threshold and breakdown is caused by the emission of a 6 nsec burst of photoelectrons from the cathode, which produces space-charge distortion of the electric field. An auxiliary trigger spark provides the necessary light and results in cathode emission up to ~10 mA/cm². The dominant wavelength region is found to be ~1100 A because of the relatively low air absorption and high photoelectric yield in this region. For a fixed gap spacing and using the highest light intensity available, the time delay is typically found to decrease from ~5t_- to a minimum delay t_- as the main gap voltage is increased from ~8% below threshold up to threshold. The minimum delay ranges from 10-60 nsec for the gap spacings studied and agrees with calculated values of gap spacing/electron drift velocity. The techniques developed have direct application to the triggering of conventional spark-gap switches and to pulsed light sources and may provide an additional tool for investigating some of the basic parameters of gaseous electronics.

11919 ELECTRICAL CONDUCTION AND BREAKDOWN IN HIGH-PRESSURE RARE GASES. R.Forman.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 594-6 (June 1, 1961).
Anode current—voltage characteristics in argon-filled, hot-cathode diodes were found to exhibit several unusual features. At high pressures (greater than 1 mm Hg) the characteristic did not follow a space-charge limited relation, but it was extremely dependent upon the cathode temperature. In addition, at cathode temperatures above 2400°C the gas broke down at anode-cathode voltages substantially less than the ionization potential of argon. The breakdown potential increased with decreasing gas pressure. It was thought that ion production at tube voltages below the ionization potential could be the result of thermal ionization at the hot cathode. G.Carter

11920 NONTHERMAL IONIZATION IN TRANSIENT HELIUM–CESIUM DISCHARGES. W.F.Westendorp, C.M.Bishop, H.Hurwitz, Jr, L.M.Goldman and D.J.BenDaniel.
Phys. of Fluids (USA), Vol. 4, No. 6, 786-7 (June, 1961).
High-speed photographs of linear transient discharges in helium, with a 10^{-4} atomic fraction admixture of caesium vapour show evidence of two discharge modes, one constricted, the other diffuse. The voltage gradient and electrical conductivity of the gas were measured, enabling calculation of the electron temperature and the caesium ionization fraction in the diffuse mode. This ionization fraction appeared to be in agreement with the Saha equation at the calculated electron temperature. G.Carter

11921 RECTIFICATION IN A 50-CYCLE DISCHARGE. P.A.Davenport.
Plasma Phys-Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 1, 32-3 (Jan., 1961).
Rectification was produced in a toroidal discharge in which the gas current was always below the Kruskal limit. Current flowed only when the electric and magnetic fields were in the same direction. The rectification was eliminated by windings added to compensate for a small transverse field component of about 1% in the axial field coil system. J.W.Sturgess

PLASMA

(See also Magnetohydrodynamics)

11922 ON THE KINETIC EQUATION FOR A HIGH TEMPERATURE PLASMA. Y.H.Ichikawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1083-1108 (Nov., 1960).

Effects of binary and ternary correlations in a high-temperature plasma are examined in detail on the basis of the so-called BBGKY equation for a system of charged particles. It is shown that the effects of ternary correlation are essential in giving rise to shielding of the interaction between particles and have important influences upon disturbances of the binary correlations. The effects of binary correlation can be divided into the correction terms of the self-consistent field of the Boltzmann–Vlasov equation and the terms representing the collision effects between particles through the shielded interaction. The effects of the collision terms are investigated in detail by deriving a generalized Fokker–Planck equation which can be reduced to the equation derived by Tchen (Abstr. 8246 of 1959) for a special case. The effects of the correction terms of the self-consistent field are examined by deriving an equation of motion of the density fluctuation which describes the longitudinal plasma oscillations. The correction terms give rise to a shift of the κ^2-term of the plasma frequency and a damping factor. The frequency of the plasma oscillations is determined to be given by

$$\omega^2 = \omega_p^2 + (1 + \delta)\,(3\kappa T/m)\,k^2$$

where the shift due to the binary correlations δ is given as

$$\delta = 1.05\{(e^2/\kappa T)^3 n\}^{1/2}.$$

The damping factor γ is determined to be

$$\gamma = 0.028\{(e^2/\kappa T)^3 n\}^{1/2}(k/k_d)^2 \cdot \omega_p$$

at the limit of $k \to 0$. It is shown that the damping factor due to the long-range binary correlations predominates over the Landau damping in the range of small value of k. On the basis of present investigation. It is concluded that the equation derived by Balescu (Abstr. 10616 of 1960) does not involve any information concerning the plasma oscillations. Since the plasma oscillations are nothing but the appearance of periodical spatial inhomogeneity in the system, it is evident that the assumption of the spatial homogeneity introduced by Temko (Abstr. 3330 of 1957), Tchen and Balescu in their derivations of the fundamental equations rules out the possible occurrence of the plasma oscillation.

11923 ON A VARIATIONAL PRINCIPLE FOR A CLASSICAL PLASMA. S.Gartenhaus.
Phys. of Fluids (USA), Vol. 4, No. 9, 1122-30 (Sept., 1961).

A time-dependent version of the Hartree–Fock method is set up for a classical system, by making use of the formal similarity between Liouville's equation for such a system and the Schrödinger equation. The use of a product trial function in the resultant variational principle produces, for a plasma, the collisionless Boltzmann equation. A second application is made to a system for which short-range correlations are small but not negligible. It is found that regardless of the range of the interparticle forces and the magnitude of the density, equilibrium is described only by a Maxwellian velocity distribution.

11924 RECOMBINATION IN A HELIUM PLASMA. A.F.Kuckes, R.W.Motley, E.Hinnov and J.G.Hirschberg.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 337-9 (April 1, 1961).

The authors studied the recombination of a low-temperature highly ionized magnetically confined helium plasma in the B-1 Stellarator (Abstr. 4743 of 1959) by observing the time variation of electron density, visible spectra, intensity of total light and electron temperature after the breakdown voltage was removed. The results support D'Angelo's suggestion (Abstr. 1894 of 1961) that the dominant mechanism in recombination of a low-temperature highly ionized plasma is the capture of an electron by an ion in a collision between the ion and two electrons. The quantitative agreement with such a hypothesis is good but fortuitous, due to the uncertainties in the relevant coefficients. M.S.Sodha

11925 ENERGY CONVERSION MECHANISM IN A BOUNDEI MAGNETIZED CURRENT-CARRYING PLASMA. G.H.Joshi.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 339-41 (April, 1961).

A linear macroscopic analysis is made of the phenomena of conversion of kinetic energy of a drifting plasma to electromagnetic energy and vice versa on account of the coupling of quasilongitudinal space-charge waves and electromagnetic waves in a finite plasma. It is suggested that very low-frequency whistler noise may be explained by this mechanism. M.S.Sod

11926 VELOCITY-DEPENDENT CORRELATIONS IN THE STATISTICAL DISTRIBUTION OF THE ELECTRIC MICROFIELD IN A PLASMA. A.Ron and G.Kalman.
Phys. Rev. (USA), Vol. 123, No. 4, 1100-5 (Aug. 15, 1961).

The polarization of a plasma in the neighbourhood of a movir ion depends on the ion velocity. This affects the distribution of the stochastic field acting upon the ion. The correction to the Holtsmark distribution due to the complete test particle–field particle correlation including this dynamic effect is calculated up to the order e^2. The result is: (1) a shift towards smaller fields (2) anisotropy, and (3) velocity dependence, which is not necessary equal to the zero velocity effect even on the average.

11927 TIME LAG IN THE THERMALIZATION OF A FAST ION IN A PLASMA. H.L.Frisch.
Phys. of Fluids (USA), Vol. 4, No. 9, 1167-71 (Sept., 1961).

The time lag in the thermalization of the spherical mean spe of a fast ion injected into a plasma is defined and computed witho solving the Fokker–Planck equation governing the distribution in speed. The time lag and certain related, recursively computable time moments can serve as local measures of the rate of evoluti of the Maxwellian distribution from an initial one, particularly fo large values of the speed. Numerical computations of the time la are presented for a fully ionized deuterium plasma for two initial conditions. Certain natural extensions of the time lag are briefly mentioned.

11928 A CONTRIBUTION TO THE KINETIC THEORY OF TE REFLECTION OF ELECTROMAGNETIC WAVES FRO A MOVING PLASMA. V.I.Kurilko.
Zh. tekh. Fiz. USSR , Vol. 31, No. 1, 71-7 (Jan., 1961). In Russi

For abstract, see Abstr. 5455 of 1961. [English translation i Soviet Physics–Technical Physics USA , Vol. 6, No. 1, 50-4 (July, 1961)].

11929 STATIONARY STATE OF A HIGH-TEMPERATURE G INSULATED PLASMA COLUMN. C.G.Fälthammar.
Phys. of Fluids (USA), Vol. 4, No. 9, 1145-51 (Sept., 1961).

On the basis of a simplified theoretical model an analysis is given of the stationary state of a cylindrical column of fully ioniz high-pressure plasma, which is heated by an axial current and cooled by heat conduction in the radial direction across the self-magnetic field of the current. The radial distributions of current magnetic field, temperature, pressure, and density are calculated and discussed. The power needed to maintain a stationary state a very high temperatures is found to be moderate. The relative importance of radiation losses is considered and found to be smal in a certain range of parameters.

11930 TRANSPORT COEFFICIENTS OF PLASMAS IN A MAGNETIC FIELD. S.Kaneko.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1685-96 (Sept., 1960).

The electric and the thermal conductivities, and the coefficie of the thermal diffusion of plasmas in a magnetic field are calcul under the assumption that the mass ratio m_2/m_1 is considerably smaller than unity, where m_1 and m_2 are masses of an ion and an electron, respectively. Thereby the terms of the order $(m_2/m_1)^{1/}$ are retained considering the application to deuterium plasma, but higher order terms than these are neglected. For various streng of the magnetic field, these coefficients are evaluated by the Chapman–Enskog method up to the 6th approximation, and the co vergence of this method is examined. The probable error of the approximation varies from 0.1% to 10% with the strength of the magnetic field.

11931 DIFFUSION OF PLASMA IONS ACROSS A MAGNETIC FIELD. J.B.Taylor.
Phys. of Fluids (USA), Vol. 4, No. 9, 1142-5 (Sept., 1961).

Earlier work on the application of the correlation function of electric field in a plasma is extended to the problem of diffusion

on cross a magnetic field. It is shown that the flux can be con-
id d in three parts; one depends on the electric field correlation
n on and the others on the dynamic friction, which is related to
he rrelation function by Nyquist's theorem. When the ion and
le on temperatures are unequal the present result differs from
na btained by a Chapman—Enskog type analysis of the transport
qu ion and the interpretation of this difference is discussed.
o consequences of the diffusion formula, as it concerns
m ities, are noted.

932 ACCELERATION OF RIGID, CONDUCTING, DIAMAGNETIC BODIES BY A MAGNETIC FIELD. R.U.Ayres.
pl. Phys. (USA), Vol. 32, No. 8, 1549-56 (Aug., 1961).

A scheme is developed for treating very fast acceleration
r esses involving plasmoids. The plasmoid is assumed to move
g oximately as a rigid body during the acceleration. Two
c led, nonlinear differential equations must be solved simultane-
n /. A power series development valid for short times is given.
examples are treated which are reminiscent, respectively, of
o ding wires in the one case, and certain propulsion devices
n e other case. Apart from an analysis of the first two terms
n e power series development, no numerical work is attempted.
result of the analysis is that the kinetic energy acquired by the
moid can quite generally be expressed as a function of distance
elled, in the form

$$\tfrac{1}{2}mx'^2(x) = C'\left[\tfrac{1}{2}(\partial L/\partial x)\big|_{x=0}\right]^{1/2} \times$$
$$\times \left\{x^{3/2} + \tfrac{1}{3}\left[(\partial^2 L/\partial x^2)/(\partial L/\partial x)\big|_{x=0}\right]x^{5/2} + \cdots\right\},$$

re L(x) is the inductance of the total circuit, depending on the
tion of the plasmoid and its shape, and C' is an experimentally
rmined constant depending on the circuit parameters and
moid mass prior to acceleration. The above expression is
valid for short distances (times).

11933 ELECTROMAGNETIC ACCELERATION OF A PLASMA SLUG. P.M.Mostov, J.L.Neuringer and D.S.Rigney.
s. of Fluids (USA), Vol. 4, No. 9, 1097-104 (Sept., 1961).

The slug model of a plasma accelerator is formulated and
lysed. The coupled nonlinear system equations involving seven
ameters are transformed into a three-parameter set. The
mulation includes as special cases Artsimovich's treatment,
ch neglects all system resistances, and Schock's treatment,
ch assumes negligible resistance of the accelerator electrodes.
all coupling, as well as small and large time asymtotic, solutions,
ch include the effect of variable rail resistance, are derived
l compared with exact computations. In cases of practical concern,
small time solutions are valid well past the first maximum of the
rent discharge, bridging the gap left by Schock's approximate
ution whose applicability is restricted to cases where the
eleration takes place over a number of cycles. Finally, it is
wn how to optimize the efficiency of an accelerator through
itable adjustment of the system parameters.

11934 MAGNETOHYDRODYNAMIC SHOCK STRUCTURE WITHOUT COLLISIONS. C.S.Morawetz.
ys. of Fluids (USA), Vol. 4, No. 8, 988-1006 (Aug., 1961).

The internal structure of a magnetohydrodynamic shock is
amined under the condition that there are no collisions among the
sma particles. The equations to be solved are the collisionless,
ady Boltzmann equations for ions and electrons coupled with
xwell's equation for the fields (a self-consistent system). There
one space variable x and all quantities are prescribed constant
$x = -\infty$. Under appropriate conditions at $-\infty$, e.g. no transverse
gnetic field, low ion pressure, and Alfvén—Mach number roughly
s than 2, the state at $+\infty$ has oscillating fields, density, etc. The
gth scale is a mean phase length. Thus a change of state is
ssible without collisions. The theory is based on an asymptotic
velopment in the ion-to-electron mass ratio and is valid over
stances that are comparable to or even large compared to the
velength of the oscillation but small compared to the ion Larmor
dius. The electrons are adiabatic.

SHOCK WAVE PHENOMENA IN COAXIAL PLASMA GUNS.
e Abstr. 11777

11935 MAGNETOHYDRODYNAMIC RESULTS FOR HIGHLY DISSOCIATED AND IONIZED AIR PLASMA.
T.Nagamatsu and R.E.Sheer, Jr.
ys. of Fluids (USA), Vol. 4, No. 9, 1073-84 (Sept., 1961).

In investigation of air plasma moving through a constant
00 gauss) transverse magnetic field was conducted in a shock tube. As the plasma travelled through the field, an electromotive force was produced in the plasma. Two diametrically opposite, $\frac{1}{2}$ in. diameter, copper electrodes were used to measure this potential. The shock Mach number varied from 10 to 32 with corresponding equilibrium plasma temperatures from 3600° to 11 000°K. At Mach 30 the observed potential across the electrodes, with a 1 MΩ external load, was 236 V, which agreed with the theoretical value, but at lower Mach numbers the observed potentials were much lower than theory. By varying the external load for a shock Mach number of 30, the current from the plasma varied from nearly zero to 115 amp. This high current was extracted from the copper electrodes at nearly room temperature. The observed potential decreased linearly with increasing current indicating a nearly constant plasma resistance. For this resistance the electrical conductivity was calculated and was much less than the theoretical prediction. The maximum power extracted from the plasma was 7.8 kW with an external load of 1.85 Ω.

11936 THE FLUCTUATING MICROFIELD AND THE MULTIPLE COLLISIONS IN A GAS OF CHARGED (OR GRAVITATING) PARTICLES. V.I.Kogan.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1374-7 (Dec. 21, 1960). In Russian.

For abstract, see Abstr. 8330 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1316-19 (May-June, 1961)].

INFRARED SPECTRA OF NITROGEN, ARGON, AND HELIUM PLASMAJETS. See Abstr. 10070

11937 TRANSFORMATION OF OBSERVED RADIANCES INTO RADIAL DISTRIBUTION OF THE EMISSION OF A PLASMA. K.Bockasten.
J. Opt. Soc. Amer., Vol. 51, No. 9, 943-7 (Sept., 1961).

A new method for transforming observed radiances into the radial distribution of the emission of a plasma is described. It is applicable to optically thin plasmas with cylindrical or spherical symmetry, which are often encountered in plasma physics and astrophysics. The observations are introduced as a sequence of n readings on the experimental curve, which are then transformed to a set of values for the emission coefficient. The transformation coefficients are tabulated for n = 10, n = 20, and, in part, for n = 40. The method is more accurate than previously published ones and is well suited for rapid calculation by electronic computers. The sources of errors are discussed and a numerical method for smoothing the readings is suggested.

11938 COMMENTS ON SYNCHROTRON RADIATION. W.E.Drummond and M.N.Rosenbluth.
Phys. of Fluids (USA), Vol. 4, No. 2, 277-8 (Feb., 1961).

The authors are now in complete agreement with the basic theoretical work of Trubnikov [Abstr. 4607 of 1961 and "Plasma Physics and the problem of controlled thermonuclear reactions", Moscow: Akademiya Nauk SSSR (1958), Vol. 3, p. 104; translation, London: Pergamon Press (1959), Vol. III, p. 122]. From further numerical evaluation, they still assert that synchrotron radiation does not represent a fatal energy drain for a moderate β, reflected, D—D reactor of a size and field strength compatible with other economic factors. R.S.Pease

11939 INTERACTION OF LOW-FREQUENCY ELECTROMAGNETIC WAVES WITH A PLASMA. D.L.Turcotte and G.Schubert.
Phys. of Fluids (USA), Vol. 4, No. 9, 1156-61 (Sept., 1961).

The interaction of a low-frequency electromagnetic wave with a semi-infinite plasma is considered. The single-fluid equations of magneto-gas dynamics are linearized in the presence of a strong, uniform, steady magnetic field. Solutions are obtained for both normal incidence and parallel propagation of the electromagnetic wave. In both cases the strong, steady magnetic field is parallel to the interface and the magnetic component of the incident wave has the same direction. In the examples considered, the parameter $\mu_0^2\sigma_0 H_0^2/\rho_0\omega$ determines the interaction between electromagnetic and acoustic modes. With normal incidence an acoustic mode is excited if this parameter is of order one. In the case of parallel propagation an appreciable parallel velocity component is excited when the governing parameter is quite small.

11940 INTERACTION BETWEEN A RADIO WAVE AND A PLASMA. T.Koga.
Phys. of Fluids (USA), Vol. 4, No. 9, 1162-6 (Sept., 1961).

The interaction between a radio wave and a plasma is studied

based on the Boltzmann equation for electrons. Collisions between electrons and heavy particles and the electric field caused by the group displacement of electrons are taken into account. The relation between the current density and the oscillating electric field is obtained. The solution is exact so far as the proposed Boltzmann equation for electrons is concerned. According to the result, the propagation of the radio wave in the plasma is investigated. As the electric field caused by the group displacement of electrons oecomes negligibly weak, the results approach those obtained by Margenau (see Abstr. 2121 of 1946; 2348 of 1958).

11941 ELECTROSTATIC INSTABILITIES IN SLIGHTLY INHOMOGENEOUS PLASMAS. E.Frieman and A.Pytte.
Phys. of Fluids (USA), Vol. 4, No. 8, 1026-31 (Aug., 1961).

Two approximate methods are presented for studying electrostatic instabilities in a spatially inhomogeneous plasma with no applied external magnetic field. The first is a perturbation procedure to be applied when the deviations from uniformity are small. The second is similar to a W.K.B. procedure to be applied when the density is a slowly varying function of position. Stability criteria are derived for both methods.

11942 STABILITY OF A CURRENT-CARRYING PLASMA. I.B.Bernstein and R.M.Kulsrud.
Phys. of Fluids (USA), Vol. 4, No. 8, 1037-9 (Aug., 1961).

The critical current is obtained for the onset of ion wave instability in the experimentally interesting case of a current-carrying plasma with an electron distribution function given by the conductivity theory of Spitzer and Härm (Abstr. 3231 of 1953). The results are presented in a form suitable for comparison with experiment.

11943 CALCULATION OF THE ELECTRODYNAMICAL EXPULSION OF AN UNDEFORMED PLASMA RING FROM A MAGNETIC "MIRROR". E.M.Moroz and I.S.Shpigel'.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 78-83 (Jan., 1961). In Russian.

For abstract, see Abstr. 5457 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 1, 55-8 (July, 1961)].

11944 ELECTROMAGNETIC DIFFUSION INTO A CYLINDRICAL PLASMA COLUMN DURING THE EARLY STAGES OF PINCH FORMATION. J.L.Neuringer, L.Kraus and H.Malamud.
Phys. of Fluids (USA), Vol. 4, No. 8, 1015-25 (Aug., 1961).

The diffusion of electromagnetic energy into a cylindrical plasma column due to the discharge of the energy stored in a capacitor is formulated taking into account the effects of the capacitance and inductance of the discharge circuit. The discharge circuit reflects the linear pinch geometry in that the energy source is a charged condenser and the return lead is a perfectly conducting cylindrical shell concentric with and surrounding the plasma column. The plasma properties enter the formulation through an extended Ohm's law which includes the time rate of change of current density. Under the assumption that changes in the ionization density and collision frequency may be neglected, Maxwell's equations lead to a third-order linear partial differential equation for the diffusion current. An exact solution is obtained by Laplace transform techniques using appropriate initial and boundary conditions which take into account the finite external circuitry. The spatial and temporal behaviour of the current density distribution as functions of the parameters which characterize both the circuit and the plasma are discussed and compared with that of an ordinary conductor obeying the simple Ohm's law.

11945 TOROIDAL HIGH-PRESSURE DISCHARGE EXPERIMENT. E.A.Smårs and R.B.Johansson.
Phys. of Fluids (USA), Vol. 4, No. 9, 1151-5 (Sept., 1961).

A toroidal gas discharge experiment in the pressure range 1 to 400 torr, was performed to test the idea of insulating a hot plasma with a high-density magnetized gas. It is found that it is possible to create an electrodeless circular arc discharge surrounded by cool gas. The surrounding high-density gas tends to stabilize the plasma ring and protects the plasma from contamination by wall impurities.

11946 EXPERIMENTS ON THE ENERGY BALANCE AND CONFINEMENT OF A MAGNETIZED PLASMA. J.Bergström, S.Holmberg and B.Lehnert.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 525-7 (May 15, 1961).

Describes a containment device, in which a rotating plasma is generated in a magnetic field due to a Helmholtz-pair coil backe off by a small coaxial central coil. The rotation is generated by currents passed between the casing of the small coil (anode) and the walls of the chamber. Stable confinement is inferred from t electrical recovery of 15% of the rotating energy (initially 135 J after 7×10^{-4} sec, for the case of a discharge in hydrogen at 45 mtorr. When the axial motion of the plasma is restricted by end plate, the device approximates to the plasma homopolar dyna and the energy is lost resistively in a short time. R.S.Pe

11947 BOUNDARY OF A PENETRATING PLASMA AND PLASMA FOCUSING. M.D.Gabovich, L.L.Pasechnik and L.I.Romanyuk.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 87-93 (Jan., 1961). In Russ

For abstract, see Abstr. 5470 of 1961. [English translation Soviet Physics–Technical Physics (USA), Vol. 6, No. 1, 61-6 (July, 1961)].

11948 RAYLEIGH–TAYLOR INSTABILITY IN A STABILIZ LINEAR PINCH TUBE. D.J.Albares, N.A.Krall and C.L.Oxley.
Phys. of Fluids (USA), Vol. 4, No. 8, 1031-6 (Aug., 1961).

Kerr-cell photographs through a mesh anode showed growin flute patterns on the interior luminous surface of the plasma cylinder. These appeared when the pressure of the enclosed ax field reversed the initial inward acceleration, as is expected for accelerational hydromagnetic analogue of the Rayleigh–Taylor instability. The measured growth rates range from about one-t to the full wave predicted by simple theory. This agreement extended over a range of operational tube conditions. As predict application of an interior stabilizing field from a central wire erased the visible fluting.

11949 THEORY OF AN ELECTROSTATIC PROBE IN A STRONG MAGNETIC FIELD. B.Bertotti.
Phys. of Fluids (USA), Vol. 4, No. 8, 1047-52 (Aug., 1961).

If the magnetic field is so strong in a plasma as to impair collective transverse drifts, all the charges supplied to the prob come mainly from a long tube of force, whose section is about o Larmor radius larger than the probe; while a diffusion process, more efficient than ordinary drifts, continuously exchanges particles between the inside and the rest of the plasma. A one-dimensional model of this process is proposed, leading to an int differential Poisson's equation, which has been studied for the c in which the collected particles are very fast. The solution cons of a chargeless, slowly decaying potential which describes the geometrical screening effect of the probe; while in the sheath an approximate boundary-layer solution matches with the probe's potential.

11950 MEASUREMENT OF ENERGY LOSSES IN PLASMA A BOLOMETRIC METHOD. L.L.Gorelik and E.A.Lobikov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 125-7 (Jan., 1961). In Russian.

For abstract, see Abstr. 5474 of 1961. [English translation Soviet Physics—Technical Physics (USA), Vol. 6, No. 1, 90 (July, 1961)].

11951 INVESTIGATION OF ELECTRODELESS DISCHARGE A MAGNETIC TRAP WITH A SUPPLEMENTARY AZIMUTHAL MAGNETIC FIELD. Ya.F.Volkob, V.T.Tolok and K.D.Sinel'nikov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 255-8 (Feb., 1961). In Russ

For abstract, see Abstr. 5456 of 1961. [English translation Soviet Physics—Technical Physics (USA), Vol. 6, No. 2, 185 (Aug., 1961)].

11952 SPECTROSCOPIC METHODS FOR THE INVESTIGATION OF A HOT PLASMA. A.N.Zaidel', G.M.Malyshev and E.Ya.Shreider.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 129-66 (Feb., 1961). In Russian.

For abstract, see Abstr. 10699 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 2, 93-119 (Aug., 1961)].

953 END-LOSSES FROM MIRROR MACHINES.
G.F.Bing and J.E.Roberts.
of Fluids (USA), Vol. 4, No. 8, 1039-46 (Aug., 1961).
Theoretical calculations are described, based on the Fokker–
k equation, of the loss of plasmas from the ends of simple
etic mirror machines. The plasma losses are described in
s of the evolution in time of distribution functions. The effects
e loss rate that arise from varying the mirror ratio of the
ines and from varying the shape of the initial distribution
ion of the plasma are discussed.

954 SPECTROSCOPIC OBSERVATIONS OF "FLUCTUATIONS" IN THE SCEPTRE IV DISCHARGE.
Williams.
ma Phys - Accelerators - Thermonuclear Res. (GB), Vol. 3,
1, 31-2 (Jan., 1961).
The variations of intensity of spectral lines was observed
igh two windows 25 cm apart. The O V line (2781A) intensity
ved clear similarities between the two positions. A phase shift
een corresponding features indicated a disturbance moving at
t 5×10^6 cm sec^{-1} opposite to the discharge current. The dis-
ance may be caused by a helical instability wave, which gives
retically a velocity of the right magnitude and direction, or a
al perturbation of plasma density. It is suggested that the in-
ity fluctuations of the O V line are mainly due to variations in
ma density. J.W.Sturgess

asma Oscillations

11955 NONLINEAR TIME-DEPENDENT PLASMA OSCILLATIONS. D.Montgomery.
s. Rev. (USA), Vol. 123, No. 4, 1077-8 (Aug. 15, 1961).
The Laplace transform technique employed by Landau to solve
problem of the first-order motions in an unbounded, rarified,
ctron plasma is modified to solve the problem to arbitrarily
h order. The transforms of the nth-order contributions are
pressible in terms of convolution integrals involving only terms
to order n–1. The method is applied to second order for the
se of square-integrable disturbances.

11956 ENHANCED DIFFUSION AND OSCILLATIONS IN WEAKLY IONIZED PLASMAS.
.Bonnal, G.Briffod and G.Manus.
s. Rev. Letters (USA), Vol. 6, No. 12, 665-7 (June 15, 1961).
Reports measurements of the rate of diffusion of ions from a
G. discharge in a direction transverse to the magnetic field.
r low fields the escape flux decreases with increasing field, but
ses through a minimum and then a maximum as the field in-
ases further. The extra, "non-classical" diffusion is found to
accompanied by high-frequency noise. These effects are
ught to be due to a new form of instability. H.N.V.Temperley

PLASMA OSCILLATIONS IN CAESIUM THERMIONIC
NVERTERS. See Abstr. 11968

11957 LOW MACH NUMBER MAGNETIC COMPRESSION WAVES IN A COLLISION-FREE PLASMA.
.Auer, H.Hurwitz, Jr and R.W.Kilb.
s. of Fluids (USA), Vol. 4, No. 9, 1105-21 (Sept., 1961).
The development of a strong hydromagnetic disturbance
velling perpendicular to an initially uniform magnetic field in a
d plasma is investigated by numerical integration of the equations
motion. The disturbance is driven by an electric field applied at
xed plane surface which coincides with the initial boundary of
plasma. If the Mach number of the resulting disturbance is less
n two, no crossing of particle orbits occurs. The disturbance
n consists of a growing train of almost independent hydromagnetic
ses progressing into the undisturbed plasma at a speed some-
t in excess of the shock velocity which would be calculated from
ssical theory. The magnitudes of the vacuum magnetic field and
vacuum–plasma interface velocity are, however, almost identical
he predictions of classical theory. These results, as well as
observed pulse spacing, can be understood in terms of a two-
ion model of the disturbed portion of the plasma together with
assumption that the pulses are accelerated by mutual interaction
l their spacing substantially exceeds their width.

11958 EXCITATION OF IONIC CYCLOTRON OSCILLATIONS IN A PLASMA BY ELECTRON BEAMS.
O.A.Glasov, L.V.Dubovoi and B.H.Rutkevich.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 84-6 (Jan., 1961). In Russian.
For abstract, see Abstr. 5486 of 1961. [English translation in: Soviet Physics–Technical Physics (USA), Vol. 6, No. 1, 59-60 (July, 1961)].

11959 PROPAGATION OF IONIC CYCLOTRON WAVES IN A PLASMA.
N.I.Nazarov, A.E.Ermakov, V.T.Tolok and K.D.Sinel'nikov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 254-5 (Feb., 1961). In Russian.
For abstract, see Abstr. 5487 of 1961. [English translation in: Soviet Physics–Technical Physics (USA), Vol. 6, No. 2, 184 (Aug., 1961)].

11960 EXPERIMENTS ON ION CYCLOTRON WAVES.
W.M.Hooke, F.H.Tenney, M.H.Brennan, H.M.Hill, Jr and T.H.Stix.
Phys. of Fluids (USA), Vol. 4, No. 9, 1131-41 (Sept., 1961).
Experiments were performed on the generation of ion cyclotron waves and their propagation into a magnetic beach. The experiments were carried out on the B-66 machine, which is currently a magnetic mirror device. Studies of the production of nuetrons have provided evidence for the absorption of the energy of these waves via ion cyclotron damping. Microwave phase-shift measurements were made, and the addition of electron density completes the list of parameters required for direct comparison of experimental and theoretical dispersion relations. The experimental data yield s smooth monotonic relation between density and frequency which is qualitatively similar to that predicted by theory. There are, however, unexplained quantitative differences. Wave propagation into the magnetic beach region was observed with a single turn r.f. magnetic probe. The variation of the amplitude of these waves in the magnetic beach is in qualitative agreement with the theory of ion cyclotron wave propagation and cyclotron damping.

11961 ELECTROSTATIC SOUND WAVE MODES IN A PLASMA. F.W.Crawford.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 663-5 (June 15, 1961).
Reports a search for ion waves in d.c. mercury vapour discharges. The frequency spectrum of anode voltage fluctuations was found to contain fairly well marked peaks, whose values can be accounted for on the hypothesis that they are the radial modes of "electrostatic sound". H.N.V.Temperley

ELECTRON EMISSION
ELECTRON BEAMS

11962 DETERMINATION OF THE EFFECT OF A STRONG FIELD ON ELECTRON EMITTERS — CRYSTALS OF CADMIUM SULPHIDE. I.L.Sokol'skaya and G.P.Shcherbakov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 167-75 (Jan., 1961). In Russian.
When field emission begins, there is a fall in the potential of the emitter; this may reach a significant fraction of the applied anode voltage. The connection between the potential drop and the emitted current under different lighting conditions and temperatures is determined experimentally. The potential drop is found to depend linearly on the applied potential. The influence of strong fields on the form of the volt–ampere emission characteristic is determined and discussed. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 120-6 (July, 1961)].
A.E.I. Research Laboratory

11963 ON THE EMISSION OF OXIDE-COATED CATHODES, BOMBARDED BY CHARGED PARTICLES.
I.A.Abroyan and S.M.Movnin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 567-74 (Feb., 1961).
In Russian.
Describes an experimental investigation of the effect of positive ions of hydrogen, helium, argon and potassium on the thermionic emission from industrial oxide-coated cathodes. The ion beam, falling on the cathode, was modulated by rectangular pulses of 10 to 200 μsec duration and of the order of 0.1 μA.

About 300 extra electrons were emitted for each ion, producing a non-rectangular pulse with rise and decay times between 15-30 μsec. The observed changes may be explained by the accumulation of donor type "defects of displacement" in the crystal lattice of the surface layer, during the retardation of the ions. [English translation in: Soviet Physics – Solid State (USA), Vol. 3, No. 2, 416-21 (Aug., 1961)]. J.M.Zarzycki

11964 ON THE THERMIONIC PROPERTIES OF ZrC, UC, AND A ZrC·UC MIXTURE.
W.E.Danforth and A.J.Williams, III.
J. appl. Phys. (USA), Vol. 32, No. 6, 1181-2 (June, 1961).

The thermionic emission constants were measured for ZrC and a ZrC—UC mixture. The results are compared with previous measurements of these materials and UC. D.Walsh

11965 SECONDARY ELECTRON (ION-ELECTRON) EMISSION FROM SINGLE CRYSTALS OF NaCl AND KCl UNDER BOMBARDMENT BY LITHIUM AND POTASSIUM IONS.
G.M.Batanov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 558-66 (Feb., 1961). In Russian.

Details are given of an experimental investigation of the secondary emission of electrons from the surface of single crystals of NaCl and KCl, bombarded by Li or K ions with energies between 0·05 and 6 keV, using a pulse method. It was found that γ varies linearly with the energy of primary ions and is independent of temperature between 130°-300°C, and that γ and its first derivative with respect to energy is several times higher than for metals. It was established that most of the secondary emission consisted of slow electrons with energies 15 eV, and no secondary emission was observed for ions below certain energy (eg. 150 eV for Li ion and NaCl crystal). The effect of changes in the surface, produced by bombardment by ions and adsorption of gases was also investigated. [English translation in: Soviet Physics-Solid State (USA), Vol. 3, No. 2, 409-15 (Aug., 1961)]. J.M.Zarzycki

11966 EXTRACTION OF ELECTRONS FROM GERMANIUM BY IONS OF CAESIUM, POTASSIUM, LITHIUM AND HYDROGEN. I.A.Abroyan.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 588-94 (Feb., 1961). In Russian.

An experimental investigation of secondary electron emission from an n-type single Ge crystal is described briefly and shows that γ is several times that for metals and that a minimum energy is required for ions to produce secondary emission, eg. 500 eV for K and Li. A theoretical discussion follows. [English translation in: Soviet Physics – Solid State (USA), Vol. 3, No. 2, 431-5 (Aug., 1961)]. J.M.Zarzycki

11967 OPTIMIZATION OF EMISSION-LIMITED THERMIONIC GENERATORS. A.Schock.
J. appl. Phys. (USA), Vol. 32, No. 8, 1564-70 (Aug., 1961).

Equations are derived describing the performance of space-charge neutralized thermionic converters with negligible transport effects. For a given anode work function and cathode temperature, optimization of the other system parameters leads to an expression for the maximum attainable conversion efficiency, in terms of the fundamental physical constants e, m, c, and k. The calculated results, presented graphically, suggest several distinct modes of high-efficiency operation, and lead to a number of interesting conclusions about converters with caesium coated cathodes. With electrodes having a thermal emissivity equal to that of hot tungsten, efficiencies in excess of 30% are shown to be possible.

11968 LOW-FREQUENCY OSCILLATIONS IN CESIUM THERMIONIC CONVERTERS. N.D'Angelo.
Phys. of Fluids (USA), Vol. 4, No. 8, 1054-5 (Aug., 1961).

The appearance of oscillations of frequencies of the order of 100 kc/s in the operation of caesium converters over certain temperature ranges is discussed in terms of the formation of a positive ion sheath in the cathode region and the development of ion—plasma oscillations. C.H.B.Mee

11969 RELAXATION OSCILLATIONS IN A PLASMA DIODE. J.M.Rocard and G.W.Paxton.
J. appl. Phys. (USA), Vol. 32, No. 6, 1171-2 (June, 1961).

Relaxation oscillations in alkali-metal vapour thermionic diodes were investigated for several electrode materials and geometries. The frequency is proportional to the square root of alkali-metal atomic weight and inversely to the electrode spacing. D.Walsh

11970 INVESTIGATION OF A CAESIUM ARC RECTIFIER. N.D.Morhulis and P.M.Marchuk.
Ukrayin fiz. Zh. (USSR), Vol. 3, No. 1, 95-103 (1958). In Ukrai with summary (1 p.) in Russian.

The results are presented of an investigation carried out i 1948-1950. A peculiarity of this rectifier is that it is possible obtain a very high discharge current density on the cathode wit an extremely small potential drop in the arc. The volt–ampere characteristics were studied at various vapour pressures and cathode temperatures. Diode operation in the rectifying regim the characteristics of a Cs diode with a tungsten cathode opera in the pulse regime, and the control of the average value of the rectified current by means of a grid (thyratron action) were an the other properties examined.

GETTER ION-PUMP FOR ELECTRON TUBES.
See Abstr. 11795

11971 THE TRANSVERSE ELECTRIC NOISE FROM AN ELECTRON BEAM. F.N.H.Robinson and R.N.Fra
J. Electronics and Control (GB), Vol. 10, No. 4, 277-84 (April,

The transverse electric noise is due to velocity componen perpendicular to the direction of an electron beam. A means o detecting the transverse noise is investigated theoretically and problem of discriminating it from shot noise is considered in detail. An experiment is described in which the measurement the transverse noise is used to demonstrate the scattering of a electron beam.

11972 VIBRATING PROBE METHOD FOR INVESTIGATIN AXISYMMETRICAL ELECTRON BEAMS.
I.K.Ovchynnyĭkov and M.S.Zinchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 219-27 (1959). In Ukra

As the proble intersects the beam, a current $I(r_0)$ is induce the probe, where

$$I(r_0) = \int_{S(r_0,\,U_p)} \left(j - \sigma j + \sigma j \int_0^{\sqrt{2\eta(U_p - U)}} f(v)\, dv \right) dS.$$

Here r_0 is the coordinate of probe position, $S(r_0, U_p)$ is the area o beam section intersected by the probe, j is the current density, the coefficient of secondary emission, η is the ratio of the elec charge to its mass, U_p is the probe potential, U is the space potential, v is the velocity of the secondary electrons, f(v) is th distribution function. The function of the probe current $I(r_0)$ ca determined oscillographically. The radial distribution of the c density in the beam is determined from $I(r_0)$ for the case $U_p <$ i.e. when

$$\sigma j \int_0^{\sqrt{2\eta(U_p - U)}} f(v)\, dv = 0.$$

The radial distribution of the space potential in the beam is de for the case $U_p > U$, i.e. when

$$\sigma j \int_0^{\sqrt{2\eta(U_p - U)}} f(v)\, dv \neq 0.$$

The radial distribution of the electron velocity is defined by a parison of the two probe current functions with two different p potentials. The theory and some experimental results illustra the possibilities of the method are discussed.

11973 THE MATCHING OF PIERCE GUNS TO TUNNELS. C.J.Milner and K.J.Ausburn.
Brit. J. appl. Phys., Vol. 12, No. 7, 346-7 (July, 1961).

All Pierce guns which shoot the maximum electron curren through two identical apertures collinear with the axis of the g have a unique ratio of cathode to anode radius. The value of th unique ratio is given for four important cases. A simple desig procedure and relevant numerical data are given.

974 ELECTRON TRAJECTORIES IN A NONUNIFORM AXIALLY SYMMETRIC MAGNETIC FIELD.
unn and R.E.Holaday.
ol. Phys. (USA), Vol. 32, No. 8, 1612-20 (Aug., 1961).
lectrons injected along the flux lines of a spatially varying, y symmetric magnetic field that is increasing in the direction ctron motion will follow approximately helical trajectories the flux lines. If the field increases too rapidly, the electrons ot be able to penetrate the magnetic field beyond a certain and will be turned back by the magnetic mirror formed by the asing field. For more slowly varying fields, the electrons enetrate the mirror with a large fraction of their energy in velocity. The equations for electrons in a sinusoidally varying etic field have been solved on a computer, and the results are nted in graphical form. An application of this field configur- as a device for converging a hollow cylindrical electron beam een tested, and measured area convergences of 15 to 1 have obtained by photographing a movable carbon screen collector .s heated by the beam. The beam is started out with a convent- parallel flow gun immersed in the magnetic field. As the beam s the first accelerating electrode it enters the region of asing magnetic field. It then shrinks in diameter and thickness, ience in area, approximately in proportion to the increase in agnetic field. The actual area convergence will be less than increase by an amount depending on the length and rate of the netic field taper.

1975 AN APPARATUS FOR AUTOMATICALLY PLOTTING ELECTRON TRAJECTORIES. J.L.Verster.
ips tech. Rev. (Netherlands), Vol. 22, No. 8, 245-59 (1960-61).
A model of the electrode system in which the electron trajec- es are to be determined is placed in an electrolytic tank. On awing board above the tank rides a three-wheel trolley, provided a stylus which is mechanically coupled to four closely spaced es, mounted in line and dipping in the electrolyte. With the aid vo computing circuits, the radius of curvature of the trajectory ribed is determined at a point midway between the probes from probe voltages. A servo system ensures that the path of the ley is given the correct radius of curvature at any given moment, hat the stylus traces out the path. The silver-plated electrodes supplied with a square-wave voltage of 500 c/s to minimize rization. An accuracy of 0.2% is achieved. The instrument also be used for the determination of equipotential lines.

1976 EQUILIBRIUM ELECTRON DISTRIBUTIONS IN ELECTRIC AND MAGNETIC FIELDS. N.Anderson.
Electronics and Control (GB), Vol. 10, No. 4 , 285-91 ril, 1961).
Equilibrium distributions of electrons are considered in tric and magnetic fields such that the distribution function only ends on the invariants of the motion of the individual particles. author assumes the motion to be collision-free and determines electric and magnetic fields as functions of the parameters of the ribution function for which he assumes a particularly simple n. The purpose of the study is to try to obtain information about reverse procedure, that is, constructing equilibrium distributions a given field configuration. It seems, from the results obtained he most simple case discussed, that the method does not offer ch promise of being able to decide the equilibrium distribution for iven field configuration, since the number of parameters in the utions for the field is too large to enable one to see its behaviour n the distribution function is varied.

1977 THE THIRD-ORDER IMAGE ABERRATIONS DUE TO ECCENTRICITY AND TILT OF THE ELECTRODES AN ELECTROSTATIC OBJECTIVE. E.Hahn.
aer Jahrbuch (Germany), 1959 (I), 86-114. In German.
The third-order aberrations of a lens field which departs htly from rotational symmetry were investigated by the general hod due to Bertein [Abstr. 659 B, 1999 B of 1948; Ann. Radio- ct. (France), Vol. 2, 379 (1947); Vol. 3, 49 (1948)]. They can be ated as aberrations of a rotationally symmetric field with the pupil laterally displaced. The displacements can be calculated he form of an integration of a perturbation function multiplied by ctions characteristic of the individual aberrations. These func- s are given for rays passing through the centre and their form alculated for a particular lens. The relationship between the turbation function and the distorted field distribution is utilized how, by an approximate method of calculation, the dependence of aberration coefficients on the geometrical perturbation para- ters. V.E.Cosslett

11978 SPECULAR REFLECTION IN THE DIFFRACTION OF SLOW ELECTRONS NEAR NORMAL INCIDENCE.
J.P.Hobson and I.H.Khan.
Phys. Rev. (USA), Vol. 123, No. 4, 1241-2 (Aug. 15, 1961).
During experiments on the diffraction of slow electrons (0-180 eV) at normal incidence, a diffracted beam was observed corresponding to the direction of specular reflection, i.e. straight back along the incident direction. This beam had properties indicating that it should not be considered as a limiting case of beams diffracted at other colatitude angles. Maxima in reflected intensity of this beam were observed at 4, 16, and 31 eV incident energy. The target used was a single crystal of tungsten with the (110) face exposed. Ultra-high-vacuum techniques were employed.

ION EMISSION . ION BEAMS

11979 THE UTILIZATION OF A HIGH-CURRENT PULSE DISCHARGE IN PROTON SOURCES.
M.D.Habovÿch, O. F.Nyemetz and Z.P.Fedorus.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 104-111 (1958). In Ukrainian.
A pulsed arc arising from the Penning–Keller discharge was studied as a possible high-current proton source. At discharge currents up to 200 A the extracted ion currents exceed 30 mA and the extracted ion current density at the exit aperture exceeds 4 A/cm^2. In spite of the difficulties encountered, it is possible to obtain reproducible, slightly modulated, rectangular ion pulses. The increase of proton content with arc current was established and amounts to as much as 85–90% in a metal chamber. A pulsed hydrogen inlet device is introduced. Attention is drawn to the use in this source of a surface of penetrating plasma (Abstr. 2342 of 1957) as the emission zone, which makes it possible to obtain high currents at relatively weak electrical fields and for small exit apertures.

11980 UTILIZING THE EFFECT OF A MAGNETIC FIELD ON A PLASMA IN ORDER TO OBTAIN INTENSE ION BEAMS. M.D.Habovÿch.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 693-5 (1958). In Ukrainian.

11981 INVESTIGATION OF THE DISTRIBUTION OF CURRENT DENSITY IN THE CROSS-SECTION OF AN ION BEAM.
S.N.Popov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 217-23 (Feb., 1961).
In Russian.
For abstract, see Abstr. 5503 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 2, 156-60 (Aug., 1961)].

11982 GRIDS FOR RADIO-FREQUENCY MASS SPECTROMETERS. V.G.Istomin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 2, 111 (March-April).
In Russian.
A method is described for making single-row grids of a working diameter of 35 mm with a spacing between wires of 0.5 mm and a transparency of 96%. It is claimed that the resolution of instruments with such grids is even better than that of instruments with mesh grids (see Abstr. 2503 of 1950; 558 of 1953). [English translation in: Instrum. exper. Tech. (USA), No. 2, 306-7 (March-April, 1958; publ. April, 1959)]. R.Schnurmann

11983 OPERATION OF THE FIELD ION MICROSCOPE WITH A DYNAMIC GAS SUPPLY.
B.J.Waclawski and E.W.Müller.
J. appl. Phys. (USA), Vol. 32, No. 8, 1472-5 (Aug., 1961).
The brightness level of the field ion microscope was increased two orders of magnitude with little loss of resolution by the addition of a dynamic gas supply system. Space charge at the emitter is not a limiting factor. Cathode sputtering by the imaging helium ions may release negative ions which are accelerated toward the tip. These ions gain sufficient kinetic energy so that irrespective of subsequent multiple ionization in the high-field region near the tip they are capable of striking the tip surface amd cause damage to the tip lattice. This effect can be eliminated by proper electrode design.

11984 ION OPTICS IN LONG, MULTISTAGE ACCELERATOR TUBES. M.Sonoda, A.Katase, M.Seki and Y.Wakuta.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1680-4 (Sept., 1960).

The recurrence formulae for the cardinal elements of a multistage accelerator tube are derived. The calculated results for an equidiameter cylindrical lens obtained by the consecutive applications of the formulae are not very different from those obtained by assuming a uniform acceleration and still show the appreciable deviations from the experimental data. The errors would, therefore, become large, unless the experimental values are used for the cardinal elements of an individual accelerating lens on which the calculation for multistage accelerator tube is based. As an example, the cardinal elements for a 12-stage accelerator tube is shown. The comparison with those obtained by the assumption of a uniform acceleration shows that the latter results are not satisfactorily accurate for such a multistage accelerator.

11985 ANISOTROPY OF CATHODIC SPUTTERING OF SINGLE CRYSTALS.
V.A.Molchanov, V.G.Tel'kovskii and V.M.Chicherov.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 1, 58-9 (March 1, 1961). In Russian.

For abstract, see Abstr. 10745 of 1961). [English translation in: Soviet Physics – Doklady (USA), Vol. 6, No. 3, 223-4 (Sept., 1961)].

11986 ANGULAR DISTRIBUTION OF SPUTTERED POTASSIUM ATOMS. R.P.Stein and F.C.Hurlbut.
Phys. Rev. (USA), Vol. 123, No. 3, 790-6 (Aug. 1, 1961).

The angular distributions of potassium particles issuing from a potassium surface under bombardment by noble-gas ions were observed under moderately good vacuum conditions. Sputtered potassium atoms were detected for incident ion energies above approximately 15 eV and useful observations of angular distributions were obtained for incident ion energies in the range 50 to 450 eV for all available values of the incident angle. A means was discovered for the discrimination between the total sputtered flux and that fraction of it possessing particle energies above a certain threshold. The apparatus and experimental procedures are described and the observed distribution patterns and a two-collision sputtering mechanism are discussed, along with related observations.

11987 THEORETICAL ASPECTS OF CATHODE SPUTTERING IN THE ENERGY RANGE OF 5-25 keV.
P.K.Rol, J.M.Fluit and J.Kistemaker.
Physica (Netherlands), Vol. 26, No. 11, 1009-11 (Nov., 1960).

For the sputtering process the important collisions of ions in the energy range 5-25 keV with lattice atoms can be considered as rigidsphere collisions. Under these conditions the angular distribution of the released atoms is independent of the masses and energy in the laboratory system, and the energy distribution of the released atoms is a constant in the allowed range. The energy transferred in the first collision is thus proportional to the maximum energy T_m which can be transferred. The collisions resulting in sputtering are those occurring near the surface. Thus the sputtering yield is assumed to be inversely proportional to the ion mean free path, inversely proportional to cos φ (φ is the angle of incidence from the normal), and directly proportional to T_m. The ion mean free path is calculated using the collision radius for a screened potential. Calculated values of the sputtering yield of copper bombarded with ions of several elements are given. The tendency of these curves is in accordance with experimental data.

G.K.Wehner

PARTICLE ACCELERATORS

11988 VOLTAGE SURGES IN AN ELECTROSTATIC GENERATOR. V.Kh.Belyaev.
Pribory i Tekh. Eksper. (USSR), 1961, No 1, 23-4 (Jan.-Feb.). In Russian.

The equivalent circuit of Millar (Abstr. 1912 of 1955) is used to calculate the voltage distribution along a Van de Graff generator under gas-insulation breakdown conditions. S.Chomet.

ION OPTICS IN LONG, MULTISTAGE ACCELERATOR TUBES.
See Abstr. 11984

11989 FREE MOTION OF PARTICLES IN ACCELERATORS WITH CONSTANT FIELD AND STRONG FOCUSING.
A.P.Fateev.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 238-53 (Feb., 1961). In Russian.

For abstract, see Abstr. 5522 of 1961. [English translation Soviet Physics–Technical Physics (USA), Vol. 6, No. 2, 171-83 (Aug., 1961)].

11990 PRELIMINARY OPERATION OF A FOUR-SECTOR RACETRACK MICROTRON. E.Brannen and H.Fro
J. appl. Phys. (USA), Vol. 32, No. 6, 1179-80 (June, 1961).

Briefly describes a microtron with focusing by means of sectional magnetic fields. Its main advantages are injection at energy and, by means of a variable straight section, release fr restrictions on injection energy and energy gain per turn.

J.W.Stur

11991 A STORE-INJECTOR FOR A PROTON SYNCHROTR A.A.Kolomenskii.
Pribory i Tekh. Elsper. (USSR), 1961, No. 1, 19 (Jan.-Feb.). In Russian.

It is a feature of large proton synchrotrons that particle injection can only take place by short (τ) pulses separated be relatively long (T) intervals. Typical τ/T ratios are 10^{-4}-10^{-5}. is suggested that since the injector is, in principle, capable of producing further pulses during the interval T, the performance proton synchrotrons could be improved by storing these pulses special store from which they could be extracted again when re In the case of a 6-10 GeV machine, and an injection energy of 1 the dimensions of the store would be quite small (about 1 m).

S.Ch

11992 A SYSTEM OF EXTREMAL REGULATION OF THE INTENSITY OF γ-RADIATION OF A SYNCHROTRO
A.P.Komar, G.F.Mikheev and N.N.Chernov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 109-15 (Jan., 1961). In Russian.

For abstract, see Abstr. 5515 of 1961. [English translation Soviet Physics–Technical Physics (USA), Vol. 6, No. 1, 78-82 (July, 1961)].

11993 THE BEHAVIOUR OF AN ELECTRON BEAM IN A BETATRON DURING THE INJECTION PERIOD.
Yu.N.Lobanov and N.I.Tulinova.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 194-9 (Feb., 1961). In Rus

For abstract, see Abstr. 5521 of 1961. [English translatio Soviet Physics–Technical Physics (USA), Vol. 6, No. 2, 138-42 (Aug., 1961)].

X-RAY TUBES AND TECHNIQUE

11994 A NEW FOCUSING X-RAY TUBE DESIGN WITH CATHODE FILAMENT REPLACEMENT UNDER VACUUM. V.D.Bezverkhyĭ.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 254-9 (1959). In Ukrain

The design permits correction of the heated cathode filame relative to the slit of the focusing cone, replacement of the filar and adjustment of the focal spot size. The tube has five window the emission of X-rays at different angles. Because of the elec static focusing of the electron beam in the X-ray tube (focal spo size about 0.1 mm or less), the exposure time of the radiograph greatly reduced, the background decreased, and the definition improved.

11995 EMPLOYING A URS-25I [IONIZATION] DIFFRACT METER FOR A STUDY OF THE CHARACTERISTIC ABSORPTION OF X-RAYS. S.M.Karal'nik.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 678-82 (1958). In Ukrai

Includes a description of the so-called "fixed counter" met for the rapid determination of relative changes in the absorptio edges of elements.

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

11996 A VIBRATING SAMPLE MAGNETOMETER. N.V.Frederick.
Trans Instrumentation (USA), Vol. 1-9, No. 2, 194-6 (., 1960).
By vibrating the sample along the axis and at the end of the -up coil, this method is claimed to combine the advantages of the instruments of Smith [Abstr. 7510 A of 1956; Rev. sci. -um.,(USA), Vol. 27, No. 5, 261-8 (May, 1956)] and Foner tr. 9747 A of 1959; Rev. sci. Instrum., (USA), Vol. 30, No. 7, 57 (July, 1959)]. The magnetizing field is also oriented along axis of the pick-up coil. The sample is very accessible, being nted at the end of a glass rod, maintained in resonance at con- t amplitude by a feedback system. Amplitude variations are ıced to 0.5% at a frequency of 60 c/s ± 4 c/s. A frequency ctive self-balancing null detector connected across the pick-up is calibrated directly in dipole moment per unit volume. A al of ~ 10 μV is produced across the coil by the susceptibility ıe glass rod itself. This compares with 0.1V for a 0.2 in.sphere owdered iron ($\mu_r \cong 7$) in a field of 1000 gauss.
Z.A.A.Krajewski

11997 MAGNETORESISTANCE MEASUREMENTS BY MEANS OF ARBITRARILY SHAPED FLAT SAMPLES. Matthews and W.R.Doherty.
Electronics and Control (GB), Vol. 10, No. 4, 273-6 (April, 1961).
A method of measuring magnetoresistance coefficients of ıic materials is described. The method utilizes two flat nples of arbitrary perimeter.

11998 SHEAR-COMPENSATED HYSTERESIGRAPH FOR THIN MAGNETIC FILMS. M.J.Schindler.
v. sci. Instrum. (USA), Vol. 32, No. 7, 862-3 (July, 1961).
An electronic device is described which will produce the B–H rve of thin films (100-100 000 A) deposited on $\frac{3}{4}$ inch disks and omatically correct for demagnetizing effects. D.J.Oliver

11999 MEASUREMENT OF MAGNETIC FIELD CONTOURS. R.Freeman.
sci. Instrum. (GB), Vol. 38, No. 8, 318-21 (Aug., 1961).
A simple apparatus is described which can be used to plot field contours of a laboratory magnet, even when the instability the field in time is comparable with the variations in space. It sists of two super-regenerative oscillators which produce nals at the nuclear magnetic resonance frequencies of the oton samples in their tank coils. One sample in fixed while the ond scans the magnetic field, and the field difference between two probes is presented in frequency units on an electronic nter. The method can be extended to make the field mapping ration completely automatic.

12000 AUTOMATIC METHOD OF MAGNETIC FIELD CALIBRATION USING PROTON RESONANCE. Horsfield, J.R.Morton and D.G.Moss.
sci. Instrum. (GB), Vol. 38, No. 8, 322-4 (Aug., 1961).
A marginal oscillator, frequency controlled by one of eleven artz crystals mounted in a motorized turret tuner, detects clear magnetic resonance signals. These signals activate a pen corder and also trigger a control circuit which advances the ret tuner to the next channel.

12001 MEASUREMENT OF THE PARAMETERS OF MAGNETIZED FERRITE USING A 36-I DIELECTRIC ST SET. E.B.Zal'tsman.
bory i Tekh. Eksper. (USSR), 1958, 79-81 (May-June). In Russian.
Two methods are described for measuring the components of the nplex magnetic permeability tensor and the complex dielectric stant in ferrites, using an industrial dielectric test set ssian type 36-I). One method described is useful in low loss rites (tan $\delta < 3 \times 10^{-3}$); the other for those having higher values oss ($3 \times 10^{-3} < \tan \delta < 10^{-2}$). [English translation in: Instrum. er. Tech. (USA), No. 3, 407-9 (May-June, 1958; publ. June, 1959)].
S.A.Ahern

12002 MAGNETIC METHOD FOR THE ESTIMATION OF FERRITE IN STAINLESS STEEL WELDS. G.C.Curtis and J.Sherwin.
Brit. J. appl. Phys., Vol. 12, No. 7, 344-5 (July, 1961).
A method is described of determining, with an estimated probable error of ±½, the percentage of ferrite in a stainless steel weld by measurement of the saturation intensity of magnetization of the weld. A calibration curve for 18/8/1 stainless steel is given, and is correlated with curves obtained with iron in wax specimens. There seems no reason why the range of 2 to 18% ferrite content actually measured should not be extended, using modified apparatus.

SQUARE-LOOP FERRITES WITH TEMPERATURE-INDEPENDENT PROPERTIES AND IMPROVED DISTURB RATIO.
See Abstr. 11450

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

12003 THE ATTRACTION OF CONDUCTING PLANES IN A VACUUM. M.Fierz.
Helv. phys. Acta (Switzerland), Vol. 33, No. 8, 855-8 (1960).
In German.
Calculations are made of the effect of temperature radiation on the attraction between two plates. This is combined with the effect of the zero point radiation. The effect of the temperature radiation should be noticeable at room temperatures for plate separations of the order of 10^{-4} cm. K.G.Major

12004 AXISYMMETRIC SOLUTIONS OF THE INCOMPRESSIBLE MAGNETOHYDRODYNAMIC EQUATIONS. A.N.Ergun.
Quart. J. Mech. appl. Math. (GB), Vol. 13, 408-27 (1960).
Davies [ibid., Vol. 13, 168-83 (1960)] has studied the axially symmetric flows of an electrically conducting and compressible fluids in the absence of the dissipative effects of viscosity, heat conductivity and electrical resistance. He has proved that the system of equations governing such flows reduces to two equations for two functions of position. One of them is Bernoulli's equation and other is the vorticity equation. The present author analyses these two equations for the case of incompressible fluids. The discussion is mainly confined to the equation of vorticity. This equation is a non-linear partial differential equation of the second order in the Stokes stream function. Many particular solutions of this equation are considered under various simplifying assumptions. The singularity of this equation is discussed in some detail.
Mathematical Reviews (R.P.Kanwal)

12005 SOME REMARKS ON THE MAGNETOGASDYNAMIC LINEARIZED THEORY. S.Ando.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1523-33 (Aug., 1960).
The general theory of magnetogasdynamic linearized flow is extended to cover the case of unsteady flow in an arbitrary direction with respect to the magnetic field. This theory is also valid in the case when the frame has "body axes" slightly inclined against the free stream direction. For the case of steady flow, a quadratic expression for the pressure disturbance is derived. Some problems when weak electromagnetic interaction exists are solved as examples.

12006 A NONEXISTENCE THEOREM IN MAGNETO-FLUID DYNAMICS. G.E.H.Reuter and K.Stewartson.
Phys. of Fluids (USA), Vol. 4, No. 2, 276-7 (Feb., 1961).
The boundary layer equations of Greenspan and Carrier [J. fluid Mech. (GB), Vol. 6, 77 (1959)]

$$f''' + ff'' - \beta gg'' = 0$$
$$g'' + \epsilon(fg' - f'g) = 0$$

fulfilling the boundary conditions

$$f(0) = f'(0) = g(0) = 0, \; f'(\infty) = g'(\infty) = 2$$

are considered. It is shown that the equations have no solutions when $\beta > 1$, such that $f''(0) \geq 0$. The nonexistence theorem is thus proved. M.Hasan

12007 ON THE FLOW OF AN ELECTRICALLY CONDUCTING FLUID NEAR AN ACCELERATED PLATE IN THE PRESENCE OF A MAGNETIC FIELD. A.S.Gupta.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1894-7 (Oct., 1960).

The flow of an electrically conducting viscous incompressible fluid due to the uniformly accelerated motion of an infinite flat plate is discussed. It is assumed that uniform magnetic fixed relative to the fluid is present. It is found that when the induced field is negligible compared to the imposed field, the velocity at any point and at any instant decreases with the increase in the magnetic field strength. It is further shown that the increase in magnetic field results in an increase in the drag suffered by the plate.

12008 TRANSIENT MAGNETOHYDRODYNAMIC DUCT FLOW. T.S.Lundgren, B.H.Atabek and C.C.Chang.
Phys. of Fluids (USA), Vol. 4, No. 8, 1006-11 (Aug., 1961).

Parallel flow of an electrically conducting viscous incompressible fluid in a rectangular duct with transverse magnetic field is considered. The walls of the duct which are parallel and perpendicular to the imposed magnetic field are taken to be non-conducting and perfectly conducting, respectively. Assuming the fluid to be at rest at the initial moment, exact solutions for the velocity and magnetic field components are obtained in the form of convolution integrals taking the longitudinal pressure gradient as an arbitrary given function of time. Later, taking a step function for the pressure gradient, these expressions are integrated. For this case, the effect of the strength of the imposed magnetic field on the development behaviour of the flow is studied. It is found that except for very large magnetic fields, the flows are overdamped.

12009 STATIONARY MOTION OF A CONDUCTING FLUID THROUGH A TUBE IN PRESENCE OF A TRANSVERSE MAGNETIC FIELD. G.A.Grinberg.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 18-22 (Jan., 1961).

For abstract, see Abstr. 8380 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 1, 12-14 (July, 1961)].

12010 THE MAGNETOHYDRODYNAMIC PROBLEM OF FLOW ROUND SOURCES OF MAGNETIC FIELD BY A STREAM OF IDEAL PERFECTLY CONDUCTING FLUID. G.A.Grinberg.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 23-8 (Jan., 1961). In Russian.

For abstract, see Abstr. 5539 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 1, 15-18 (July, 1961)].

12011 AXISYMMETRIC PERTURBATIONS IN A CONDUCTING LIQUID CONFINED BY RIGID WALLS. P.W.Manuel and J.H.Blackwell.
Phys. of Fluids (USA), Vol. 4, No. 8, 1012-14 (Aug., 1961).

A study is made of axisymmetric perturbations in a conducting liquid confined by a rigid non-conducting cylindrical wall. In one case the liquid is inviscid, and may have a constant equilibrium axial velocity. In the other the liquid is viscous and can have no equilibrium velocity. Stable solutions are found for all wave numbers and the results are compared with those of Tayler (Abstr. 5565 of 1961) for similar problems with nonrigid walls.

12012 SIMPLE MAGNETOSONIC WAVES. H.Ya.Lyubars'kyĭ and R.V.Polovin.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 567-70 (1958).
In Ukrainian.

It is shown in ordinary hydrodynamics that in a simple wave the points possessing greater density move at greater velocity than those with lower density, if the following inequality is true:

$$\left(\frac{\partial^2}{\partial p^2}\frac{1}{\rho}\right)_s > 0$$

Three types of simple wave exist in magnetohydrodynamics — fast and slow magnetosonic and magnetohydrodynamic waves. The third type of wave is characterized by constant density and constant velocity. As for the first two types, it may be proved that the points of greater density move more rapidly if the foregoing condition is satisfied. Hence, self-similar waves are always rarefaction waves. The dependence of the phase velocity on the density leads, as in ordinary hydrodynamics, to the continuation of liquid compression in the areas of compression, until a shock wave is formed. The magnetic field intensity varies in the same (opposite) way as the density if the simple wave is fast (slow).

12013 THE IMPOSSIBILITY OF RAREFACTION SHOCK WAVES IN MAGNETOHYDRODYNAMICS. R.V.Polovin and H.Ya.Lyubars'kyi.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 571-4 (1958). In Ukrainian.

Rarefaction shock waves are impossible in magnetohydrodynamics if the adiabatic compression decreases with increase of pressure, and if, at constant volume, an increase in temperature causes an increase in pressure. The magnetic field increases if a shock wave is fast (Abstr. 2524 of 1959).

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

12014 SOLUTION OF BOUNDARY VALUE PROBLEMS OF ELECTROMAGNETIC FIELDS BY INTEGRAL EQUATIONS. P.Szulkin.
Arch. electrotech. (Poland), Vol. 9, No. 2, 245-60 (1960). In Po

The field is induced by singular point sources distributed o the surface of a perfectly conducting body; the coordinate syste hosen so that one of its coordinate surfaces coincides with the given source surface. The field then can be described as an inf series of orthogonal wave functions by deriving the suitable vec or scalar potentials in terms of appropriate Green's functions. ome relations between the wave functions are noted.

J.K.Skwirzy

THEORY OF PHOTON PACKETS. See Abstr. 11825

12015 INDUCED AND SPONTANEOUS EMISSION IN A COHERENT FIELD. IV. I.R.Senitzky.
Phys. Rev. (USA), Vol. 123, No. 5, 1525-37 (Sept. 1, 1961).

For Pt III, see Abstr. 17094 of 1960. In Pts I-III of this se dealing with the interaction between a number of molecules and electromagnetic field in a resonant cavity, both the molecules a the field were treated by perturbation theory. The perturbation restriction on the field is removed in the present article, allowi large changes in the field, but the molecules are still assumed undergo a small change during the time under consideration. T justification for this type of analysis, involving the generalizati the conventional concepts of induced and spontaneous emission, applicability to a molecular amplifier during the buildup period, and the re-examination of a calculation by Serber and Townes c cerning the fundamental limits of molecular amplification are discussed. Two different molecular distributions are considere In one (the resonant case) all molecules have the same frequenc as the cavity, and in the other (the nonresonant case) there is a uniform frequency distribution. The molecules are assumed to initially in an emissive state. Several types of driving fields ar considered. Expressions are obtained for the field operators b solution of a Volterra integral equation, and expectation values obtained for the field strength and field energy. In the resonant case, both the coherent and incoherent fields increase exponenti after a sufficiently long time, no matter how small the initial ga is. Their ratio becomes constant and is equal to the number of photons in the driving field only in the absence of dissipation. A interesting related result is the fact that the signal-to-noise rat for constant signal input power increases as the cavity dissipati increases. An estimate of the total time for which the theory is valid is obtained from a consideration of the energy emitted by molecules. Contact is made with perturbation theory for sufficie small gain and short time. In the nonresonant case the effect o the molecules is shown to be that of a negative dissipation. In contrast to the resonant case, the gain becomes exponential only if the negative dissipation exceeds, in absolute value, the true dissipation. The ratio of induced to spontaneous emission is, in this case also, equal to the number of photons in the driving fiel only in the absence of dissipation. However, the signal-to-noise ratio for constant input power drops with increasing cavity dissipation.

016 100-200 kMc WATER CALORIMETER.
J.B.Thaxter and J.McGowan,III.
Sci. Instrum. (USA), Vol. 32, No. 5, 605-6 (May, 1961).
The calorimeter, whose construction and performance are ied, measures millimetre-wave power levels from a few watts to 5 × 10^{-5} watts, with a response time of 20 sec.
L.M.Roberts

2017 THE PROBLEM OF DIFFRACTION OF ELECTRO-MAGNETIC WAVES BY A PERFECTLY CONDUCTING NE RING. G.A.Grinberg and É.N.Kolesnikova.
ekh. Fiz. (USSR), Vol. 31, No. 1, 13-17 (Jan., 1961). In ian.
For abstract, see Abstr. 5593 of 1961. [English translation in: et Physics–Technical Physics (USA), Vol. 6, No. 1, 8-11 , 1961)].

2018 THE DISPERSION CHARACTERISTICS OF A HELIX SITUATED IN A PLASMA.
.Ivanova and V.S.Mikhalevskii.
otekhnika i Elektronika (USSR), Vol. 4, No. 11, 1932-3 (Nov.,). In Russian.
The effect on the dispersion characteristics of a helix of ounding it with a plasma, the dielectric constant of which nds on its electron concentration, is investigated. The ersion curves are plotted for two different plasma frequencies show that the dispersion characteristics are substantially cted by the presence of the plasma and may even exhibit itive dispersion. The measured dispersion curves show good itative agreement with the calculated curves. The arrangement vides a means of varying the dispersion properties of helices iout altering their geometrical dimensions. R.C.Glass

12019 PROPAGATION OF CENTIMETRIC WAVES IN WAVE-GUIDES FILLED WITH PLASMA FROM THE SITIVE COLUMN OF A DISCHARGE. I.
.Golant, A.P.Zhilinskii, M.V.Krivosheev and G.P.Nekrutkina.
tekh. Fiz. (USSR), Vol. 31, No. 1, 55-62 (Jan., 1961). In Russian.
For abstract, see Abstr. 9687 of 1961. [English translation in: iet Physics – Technical Physics (USA), Vol. 6, No. 1, 38-43 ly, 1961)].

12020 PROPAGATION OF CENTIMETRIC WAVES IN WAVEGUIDES FILLED WITH PLASMA FROM THE SITIVE COLUMN OF A DISCHARGE. II.
.Golant, A.P.Zhilinskii and M.V.Krivosheev.
tekh. Fiz. (USSR), Vol. 31, No. 1, 63-70 (Jan., 1961). In Russian.
For abstract, see Abstr. 9688 of 1961. [English translation in: iet Physics – Technical Physics (USA), Vol. 6, No. 1, 44-50 ly, 1961)]

2021 THE SCATTERING OF ELECTROMAGNETIC WAVES IN THE IONOSPHERE AND TROPOSPHERE ON OMOGENEITIES CAUSED BY TURBULENT PULSATIONS.
.Herman.
ayin. fiz. Zh. (USSR), Vol. 3, No. 5, 595-610 (1958).
Ukrainian.
The presence of turbulent pulsations in the troposphere and posphere leads to the appearance of a scattering field, supple-tary to the incident wave, modulated in frequency. The appear-e of scattered radiation is physically connected with the presence dielectric constant of the supplementary field, due to pulsations he polarization vector of the medium, defined by the formula:

$$\vec{P}_1 = \frac{\delta\epsilon}{4\pi}\vec{E}.$$

intensity of scattered radiation in dry air

$$J = J_0\int e^{i\vec{q}\vec{r}}\delta\rho\,\delta\rho'\,d\tau_{\vec{r}}$$

ully defined by the correlation moment of the densities. On uming homogeneous and isotropic turbulence, and applying the istical hypothesis of Millionshchikov (1939), the equation for nsity will have the following form for the important special e of developed turbulence, when $v^2/a^2 \ll 1$:

$$\frac{\partial^2}{\partial t^2}J + 2(a^2q^2 - \Omega^2)J = 0.$$

Hence, the frequency of intensity modulation equals

$$\frac{2\sqrt{2}a\omega}{c}\sin\frac{\Theta}{2}\left(1 - \frac{\Omega}{a^2\left(\frac{2\omega}{c}\right)^2\sin^2\frac{\Theta}{2}}\right)^{1/2}$$

and, irrespective of the initial conditions and form of perturbation, depends, only on the Langmuir natural frequency of ionospheric plasma oscillations, the velocity of sound propagation, the frequency of the scattered radiowave and the scattering angle Θ. This frequency modulation of intensity is an analogue to the Mandelstam effect for radiowave scattering on inhomogeneities of turbulent pulsations, characterized by the propagated wave of the correlation moment of density in the turbulent troposphere or ionospheric plasma. The frequency modulation of the intensity of scattered radiowaves, and the dependence of the intensity on the scattering angle should vanish if the dimensions of region l, in which the correlation moment is markedly different from zero, is considerably less than q^{-1}, i.e.

$$ql \equiv \frac{4\pi l}{\lambda}\sin\frac{\theta}{v} \ll 1.$$

A similar result is obtained by an examination of the scattering problem for homogeneous isotropic turbulence in a viscous compressible fluid, on taking into account the heat conductivity for the last stage of turbulence degeneration, when the third correction moment can be neglected. In this case, it can be added to what was noted in the foregoing that the radiowave scattering intensity is proportional to the value $\exp(-2\nu q^2 t)$ whence it follows that the modulation can be observed during time intervals which are small in comparison with the damping time of the last stage of turbulent motion.

12022 THE SCATTERING OF ELECTROMAGNETIC WAVES ON INHOMOGENEITIES DUE TO TURBULENT PULSATIONS UNDER NON-STATIONARY TURBULENT CONDITIONS.
V.L.Herman.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 617-23 (1958). In Ukrainian.

Radiofrequency Spectroscopy Techniques

12023 MICROWAVE CAVITY FOR HIGH TEMPERATURE ELECTRON SPIN RESONANCE MEASUREMENTS.
L.S.Singer, W.H.Smith and G.Wagoner.
Rev. sci. Instrum. (USA), Vol. 32, No. 2, 213-14 (Feb., 1961).
An X-band TE102 rectangular resonant cavity for use up to 1200°C is described. This is a modification of a design by Ingram [Proceedings of the 3rd Conference on Carbon. New York: Pergamon Press (1959) p. 94]. The Varian adjustable iris is used to couple the cavity to the microwave circuit. Specimens are contained in a quartz tube furnace resistively heated; the resonant cavity is maintained at room temperature by water cooling. It is shown that good temperature stability and uniformity are obtained with this arrangement. By careful adjustment of the orientation of the specimen tube and furnace, Q values close to that of the unperturbed cavity can be obtained. S.A.Ahern

12024 THE DETERMINATION OF THE SHAPE AND WIDTH OF VERY NARROW LINES IN NUCLEAR MAGNETIC RESONANCE. G.Hochstrasser.
Helv. phys. Acta (Switzerland), Vol. 34, No. 3, 189-239 (1961).
In French.
A spectrometer which works in the earth's field was constructed allowing a resolution better than 1μ gauss to be obtained. The apparatus was used to measure the natural line width of certain substances including water and benzene and also to study the departure of the shapes from Lorentzian form. An automatic version was used to study fluctuations in the earths magnetic field.
D.J.Oliver

12025 A PARAMETRIC SPECTROGRAPH FOR QUADRUPOLE RESONANCE. A.Jelenski.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 649-55 (1960).
In French.
9th Colloque Ampere Paper (see Abstr. 4734 of 1961). Detail is given of a parametric amplifier and of the spectrograph in which

it is incorporated. Theory of operation, and characteristics of the complete equipment are discussed. Performance is illustrated in the presentation of the quadrupole resonance of bromine in p-dibromobenzene at 226 Mc/s. The signal-to-noise ratio is at least equal to that obtained with spectrometers employing valve amplifiers. J.Sheridan

12026 THE THREE-LEVEL GAS MASER AS A MICROWAVE SPECTROMETER. T.Yajima and K.Shimoda.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1668-75 (Sept., 1960).

A method of microwave spectroscopy using three-level maser action is described and preliminary experiments on HDCO are described. A b-type transition $3_{03} \leftarrow 2_{12}$, which is connected with an a-type transition $2_{11} \leftarrow 2_{12}$, was definitely assigned by the observation of three-level maser action. Moreover, the weak transition, $3_{03} \leftarrow 2_{12}$, was observed with very good signal to noise ratio by using the strong transition, $2_{11} \leftarrow 2_{12}$, as a detecting transition. Theories of the three-level maser action is gases are also compared with experiment and shown to be in good agreement. Further applications of the three-level gas maser as a spectrometer as well as an amplifier are discussed.

12027 TECHNIQUES INVOLVED IN THE STUDY OF DIFFERENT NUCLEI BY HIGH RESOLUTION NUCL MAGNETIC RESONANCE. H.J.M.Fitches and J.L.Williams.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 555-66 (1960).
9th Colloque Ampère Paper (see Abstr. 4734 of 1961).

N.M.R. spectrometers currently used are not too well suited for the study of different nuclei. The authors consider the factor involved in studying different nuclei and give a brief account of t techniques they have developed to overcome this problem.
W.J.Orville-Thom

12028 EXPERIMENTAL PROCEDURE FOR THE DETERMINATION OF THE NUMBER OF PARAMAGNETIC CENTERS. A.Yariv and J.P.Gordon.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 462-3 (April, 1961).

A procedure is described for determining the number of paramagnetic centres contributing to a paramagnetic resonance measuring the reflection coefficient of a reflection cavity contain the sample, both on and off resonance. This may be done with conventional equipment for measuring reflection coefficients. T procedure is simplified if a variable coupling cavity is used.
J.M.Ba

NUCLEAR PHYSICS

12029 LOW AND MEAN ENERGY NUCLEAR PHYSICS COLLOQUIUM. (GRENOBLE, FEBRUARY-MARCH, 1960).
J. Phys. Radium (France), Vol. 21, No. 5, 265-501 (May, 1960).
In French.

This conference was organised by the Section de Physique Corpusculaire of the Société Française de Physique and supported by the University of Grenoble. A total of 81 papers was presented covering a wide range of nuclear physics studies, and including both short articles on specific subjects of research and longer general surveys. Many articles refer to recent work undertaken at the nuclear physics department of C.E.N., Saclay. Abstracts will be found under the appropriate headings in this or subsequent issues of Physics Abstracts.

12030 SCIENTIFIC APPLICATIONS OF NUCLEAR EXPLOSIONS. G.A.Cowan.
Science (USA), Vol. 133, 1739-44 (June 2, 1961).

Nuclear explosions are of interest to the research scientist as uniquely intense sources of neutrons, neutrinos, plasmas, high temperatures, gamma-rays, X-rays, light, shock-waves and radioactive isotopes. The various experiments which might be carried out to exploit these properties are reviewed.

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

12031 COUNTING EFFICIENCY OF GAMMA RAYS IN COUNTER TUBES. T.Suzuki and J.Yuhara.
J. Phys. Soc. Japan, Vol. 16, No. 2, 152-6 (Feb., 1961).

The counting efficiency of γ-rays in cylindrical counters and end-window counters was examined by means of a very thin sheet and a collimated fine pencil beam of γ-rays. The distribution of the number of γ-rays emitted from the thin slit was measured by means of a end-window counter or by the effect of the fine anode wire of the cylindrical counter. When the plane of the thin sheet of γ-rays reaching from side to a cylindrical counter was parallel to the axis, the counting efficiency registered a maximum value at the position where the sheet of γ-rays was in contact with the inner surface of the counter, and a smaller value near the central wire but when the pencil beam of γ-rays was parallel to the anode wir and the γ-rays entering the counter through the end-window plate the counting efficiency gave a maximum value at the anode wire a the inner surface of the counter. An average efficiency for a she of γ-rays which are in a plane perpendicular to the counter axis was also investigated.

12032 A-C IONIZATION CHAMBERS ARE SIMPLE AND RELIABLE. D.L.Roberts.
Nucleonics (USA), Vol. 19, No. 2, 53-7 (Feb., 1961).

An investigation into the characteristics of B ionization cham polarized with a.c. voltages. British RC/1 ionization chambers with electrode spacings of 6 mm and 180 cc active volume were filled with various gases; typically H, He or N at 15 cm pressure Two useful modes of operation are possible — weak field with applied voltage of less than 1 V r.m.s. and saturated field with sufficient voltage to achieve complete ion collection. In the weak field region the current is proportional to the applied voltage tho the waveform may be distorted by peaks due to rapid electron collection. The chamber can be connected directly into a bridge circuit and used to actuate reactor traps. The circuit can be arranged to trip in amplitude, phase or frequency and by using a relay in a quadrature circuit fail-safe protection is achieved. In high-voltage mode of operation the current is directly proportion to the flux ϕ [in the weak-field recombination causes the current vary as $\phi^{0.8}$] and a wide range of operation can be achieved. The shape of the output current waveforms, the use of square-wave operation and the effects of filling gas and temperature variation are discussed. Spurious effects arising from the capacitance of t B coatings were eliminated by evaporating an Al film over the coating. R.D.Sr

12033 CALCULATION OF IONIZATION CHAMBERS WITH GRIDS. O.F.Nyemets', Ye.A.Pavlenko and M.V.Soko
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 837-9 (1958). In Ukrainia

12034 STUDY ON SPARK COUNTERS OF THE ROSENBLU TYPE FOR COUNTING α PARTICLES AND NEUTRO
S.Kawata.
J. Phys. Soc. Japan, Vol. 16, No. 1, 1-6 (Jan., 1961).

In the case of a single-wire counter, the number of counts w investigated when the α-particle source was moved parallel to t cathode plate, and in relation to the voltage applied to the anode wire and also when the source was moved perpendicularly to the cathode plate. The effects of temperature, pressure and humidit of the surrounding air on counts were investigated, and the effici

iting of α-particles was estimated. Experiments were also
d out for a multiple-wire counter. A counter with 14 anode
was constructed, and it was found that uniformity of counting
h the whole acting region might be greatly improved by
ing a high resistance in series with each wire. A neutron
or was constructed by putting a boron-coated glass plate
the multiple wires and surrounding the counter with paraffin.

12035 FAST-NEUTRON SCINTILLATION-LAYER DETECTOR FOR MEASUREMENTS AGAINST γ-RAY GROUND. W.S.Yeffseyev, W.J.Komarov, W.Kusch, oganov, W.A.Tchernogorova and M.Szymczak.
hys. Polon. (Poland), Vol. 19, No. 6, 675-82 (1960).
escribes a scintillation-layer detector with high detection
ency for fast neutrons and with low efficiency for γ-rays.
etector is designed for the neutron measurements in the
MeV energy range. Its operation is based on the difference
nge between protons and electrons of the same energy.

12036 ANGULAR DEPENDENCES OF EFFICIENCIES FOR SODIUM-IODIDE CRYSTALS.
ke, A.Nakamoto, Y.Takami, M.Hattori and S.Okano.
ys. Soc. Japan, Vol. 15, No. 4, 737-8 (April, 1960).
The variation of detection efficiency with the incident direction
mma-rays was calculated for energies in the range 0.1 to 2.0
. Graphs of the efficiency versus angle are given for two
tals, 1 in. diameter × 1 in. long, and 1.5 in. diameter × 1 in.
J.L.Redding

ack Visualization

12037 A HYDROGEN-CONTAINING LIQUID IN A BUBBLE CAMERA FOR OPERATION AT ROOM TEMPERATURE.
.Lomanov and V.A.Shchegolev.
bory i Tekh. Eksper. (USSR), 1958, No. 3, 103 (May-June).
ussian.
A bubble chamber liquid, consisting of propane and ethane
he volume ratio 2 : 1, was successfully used at 25°C, at which
perature its saturated vapour pressure was 23 atm. When the
ssure was raised to 38-40 atm and the liquid then suddenly
anded to pressures below 10 atm, traces of Compton electrons
duced by a Co^{60} source were observed. No additional technical
iculties were introduced by the use of the mixture. [English
nslation in: Instrum. exper. Tech. (USA), No. 3, 435 (May-June,
8; publ. June, 1959)]. J.D.Dowell

12038 ON THE OPERATION OF THE DISCHARGE CHAMBER.
F.T.Arecchi, G.Cavalleri, E.Gatti and G.Redaelli.
ergia nucleare (Italy), Vol. 8, No. 3, 213-16 (March, 1961).
A discharge chamber, several cms in diameter, filled with
5% Ne, 2.5% A at atmospheric pressure, was operated with a
ld of 8 kV cm^{-1} between the electrodes and a Po α-particle
rce inside the chamber. When the direction of motion of the
particles was parallel to the electrodes, luminous traces of the
ne length as the expected range of the α-particles and about
cm wide, were observed. With the source on the anode, thinner
minous traces, some of which branched into two, were observed
rminating on the cathode. The time constant of the voltage pulse
s 2.5×10^{-8} sec and the width of the traces parallel to the elec-
des was equal to the distance one would expect the ions to drift in
s time. J.L.Redding

12039 MICROWAVE DISCHARGE CHAMBER.
S.Fukui and S.Hayakawa.
Phys. Soc. Japan, Vol. 15, No. 3, 532 (March, 1960).
The possibility is discussed of a discharge chamber for the
tection of ionizing particles in which a microwave rather than a
c. pulse is applied and is responsible for the multiplication of the
ctrons produced by the particle. Such a device would have the
vantages of much lower track distortion than in expansion
ambers, short sensitive time, suitability for coincidence work and
mplicity of construction. Microwave power requirements are
nsidered. The field strengths needed correspond to several
egawatts, but these could be obtained using a conventional magnetron
d a cavity of high Q-value as the expansion chamber.
R.E.Meads

NUCLEAR FIELD THEORY

12040 CONNECTION BETWEEN WIGHTMAN FUNCTIONS AND GREEN FUNCTIONS IN p-SPACE. D.Ruelle.
Nuovo Cimento (Italy), Vol. 19, No. 2, 356-76 (Jan. 16, 1961).
The analytic properties of the Wightman function W are established for the case in which only the time is regarded as a complex variable. A truncated Wightman function $\widetilde{W}$ is introduced, and from it the Green function G is deduced, thus extending the results of O.Steinmann on the 4-point function. The boundary value of G is the Fourier transform of the least value of the vacuum product T of the fields, and is the analytic continuation of the retarded L.S.Z. function in momentum space. Finally a set of properties is established which together characterize G, in the sense that if G has these properties, there exists one and only one function $\widetilde{W}$ with the required properties, and such that G derives from it. I.J.R.Aitchison

12041 CURRENT–CHARGE DENSITY COMMUTATION RELATIONS. K.Johnson.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 431-4 (June, 1961).
It is shown that the non-vanishing of the current–charge density commutator at equal times is required by and is compatible with the continuity equation in quantum electrodynamics.

12042 FURTHER CONSIDERATIONS ON ELECTROMAGNETIC POTENTIALS IN THE QUANTUM THEORY.
Y.Aharonov and D.Bohm.
Phys. Rev. Vol. 123, No. 4, 1511-24 (Aug.15, 1961).
The authors discuss in further detail the significance of potentials in the quantum theory, and in so doing, they answer a number of arguments that have been raised against the conclusions of their first paper on the same subject (Abstr. 12997 of 1959). Then they proceed to extend the treatment to include the sources of potentials quantum-mechanically, and show that when this is done, the same results are obtained as those of the first paper, in which the potential was taken to be a specified function of space and time. In this way, the authors not only answer certain additional criticisms that have been made of the original treatment, but also bring out more clearly the importance of the potential in the expression of the local character of the interaction of charged particles and the electromagnetic field.

12043 GAUGE INVARIANCE AND RENORMALIZATION CONSTANTS. L.Evans, G.Feldman and P.T.Matthews.
Ann.Phys. (USA), Vol. 13, No. 2, 268-83 (May, 1961).
Using only general considerations such as translation invariance, positive definite energy spectrum and gauge invariance, spectral representations have been set up for the vacuum expectation values of two photon and two electron operators in quantum electrodynamics. The gauge dependence of such quantities is thus clearly exhibited, particularly that of equal time commutators and of propagators. Certain constants, related to the renormalization constants, integrals of the spectral function are defined and shown to be gauge invariant. The generalized Ward identity is established in any gauge.

12044 THE INFRARED DIVERGENCE PHENOMENA AND HIGH-ENERGY PROCESSES.
D.R.Yennie, S.C.Frautschi and H.Suura.
Ann. Phys. (USA), Vol. 13, No. 3, 379-452 (June, 1961).
A general treatment of the infrared divergence problem in quantum electrodynamics is given. The main feature of this treatment is the separation of the infrared divergences as multiplicative factors, which are treated to all orders of perturbation theory, and the conversion of the residual perturbation expansion into one which has no infrared divergence, and hence no need for an infrared cutoff. In the infrared factors, which are exponential in form, the infrared divergences arising from the real and virtual photons cancel out in the usual way. These factors can then be expressed solely in terms of the momenta of the initial and final charged particles and an integral over the region of phase space available to the undetected photons; they do not depend upon the specific details of the interaction. Electron scattering from a static potential is treated in considerable detail, and several other examples are discussed briefly. As an important by-product of the general treatment, it is found that when the infrared contributions

are separated in a particular way, they dominate the radiative corrections at high energies and together with certain "magnetic terms" and vacuum polarization corrections seem to give all the contributions proportional to ln(E/m). All of these corrections can be easily estimated (in most cases) simply from a knowledge of the external momenta of the charged particles; this then provides a very powerful and accurate way of estimating radiative corrections to high-energy processes.

12045 INTRINSIC MAGNETIC MOMENT AS A NONRELATIVISTIC PHENOMENON. A.Galindo and C.Sanchez del Rio.
Amer. J. Phys., Vol. 29, No. 9, 582-4 (Sept., 1961).

It is shown that the Hilbert space of spin $\frac{1}{2}$ particles, elementary under the Galilei group, decomposes into two subspaces invariant under the "static" Galilei group. This fact implies a linearization of the Schrödinger equation and suggests a square-root procedure to introduce electromagnetic interactions leading to the right expression for the intrinsic magnetic moment of the particle without using relativity. The procedure can be used to introduce the electron intrinsic magnetic moment in a more convincing way than is usual in textbooks.

12046 ON THE THEORY OF PARTICLES OF SPIN 1. N.Kemmer.
Helv. phys. Acta (Switzerland), Vol. 33, No. 8, 829-38 (1960).

The quantum field theory of particles of spin one is investigated. Various alternative formulations of the theory are discussed and general criteria are obtained subject to which the theory is renormalizable. The theory of Yang and Mills is quoted as an example.
R.F.Peierls

12047 VECTOR FIELD ASSOCIATED WITH THE UNITARY THEORY OF THE SAKATA MODEL.
A.Salam and J.C.Ward.
Nuovo Cimento (Italy), Vol. 20, No. 2, 419-21 (April 16, 1961).

The theory is shown to contain eight vector mesons in addition to the original three particles p, n, Λ, if the kinetic energy part of the Hamiltonian is required to be invariant under gauge transformations in the internal symmetry space. The mesons may be identified with K and π mesons, and one isoscalar meson. A similar treatment for weak interactions is indicated. D.W.L.Sprung

12048 FURTHER REMARKS ON THE PROPOSED μ–e SELECTION RULE. N.Cabibbo and R.Gatto.
Nuovo Cimento (Italy), Vol. 19, No. 3, 612-14 (Feb. 1, 1961).

The μ–e symmetry postulated previously by the authors leads to a multiplicative conservation law. This law follows from, but does not imply, an additive conservation law. Some consequences of the latter, and possible tests for its validity are considered.
E.J.Squires

12049 RESONANCE EFFECTS IN INTERMEDIATE BOSON THEORY. P.T.Matthews and A.Salam.
Nuovo Cimento (Italy), Vol. 19, No. 4, 837-9 (Feb. 16, 1961).

It is pointed out that if there exists an intermediate boson mediating the four-fermion interaction of the type proposed by Tanikawa and Watanabe (Abstr. 5359 of 1959) then one can expect quite low energy resonance phenomena (~300 MeV) in neutrino–nucleon interactions. The cross-section should be about 10^5 times that expected with no intermediate boson. R.F.Peierls

12050 APPROXIMATE SOLUTION OF THE BETHE–SALPETER EQUATION FOR TWO FERMIONS.
M.Kawaguchi.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 178-88 (Feb., 1961).

The eigenfunction and the binding energy of the ground state are obtained for the bound state of two fermions which interact through photons or scalar photons in the ladder approximation. The Bethe–Salpeter equation is separated into four independent sets of equations by applying the Tani–Foldy–Wouthuysen transformations. (Abstr. 5526 of 1950; 754 of 1952). These equations are further simplified if a part of the recoil is neglected. Retardation is completely taken into account. The wave-function is expanded in a form convenient to obtain spin singlet and triplet solutions. As an example, the ground state of positronium is solved using Wick's method. (Abstr. 750 of 1955).

12051 NOTE ON THE INTEGRAL REPRESENTATION OF COMMUTATORS. K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 211-14 (Feb., 1961).

The difference is discussed between the integral representations of Dyson (Abstr. 5654 of 1958; 1047 of 1959) and of Deser et al. (Abstr. 13018 of 1959; 3934-5 of 1960). It is shown that one can determine the vanishing region of the weight function for the latter representation from the spectral condition. Hence, one cannot prove the forward dispersion relation for nucleon–nucleon scattering in Deser et al.'s sense from the integral representation alone.

12052 ON A SYMMETRICAL SCHEME OF INTEGRAL EQUATIONS FOR SPECTRAL FUNCTIONS.
K.Ter-Martirosyan.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 353-67 (June, 1961).

A self-contained set of integral equations for the spectral functions of the scattering amplitudes was obtained in two-particle approximation. The equations are perfectly symmetrical with respect to the three channels of the "four-tail" vertex; if the Mandelstam spectral representation is written with allowances for subtraction, it leads to a coupled set of equations connecting the spectral functions of two types: depending on two variables and on one variable. The iteration of the equations over the coupling constants yields the contribution of a class of renormalized Feynman graphs consisting in each part of two parts connected by two lines (only a portion of the contribution of these graphs is adequately taken into account, i.e. that which has singularities at the two-particle production threshold). If the spectral functions depending on two variables are neglected, there remain the equations of the type obtained by Chew and Mandelstam and by Cini and Fubini. See also following abstract.

12053 EQUATIONS FOR SPECTRAL FUNCTIONS IN THE SIMPLEST CASES. K.Ter-Martirosyan.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 368-84 (June, 1961).

The integral equations for the spectral functions of "four-tail" amplitudes are written in detail for the case when two of the four particles are identical. The equations obtained are applicable to the cases of the π–π, π–K, and K–K interactions, the spins and isopins of all particles being assumed equal to zero.

12054 DYNAMICAL THEORY FOR STRONG INTERACTIONS LOW MOMENTUM TRANSFERS BUT ARBITRARY ENERGIES. G.F.Chew and S.C.Frautschi.
Phys. Rev. (USA), Vol. 123, No. 4, 1478-86 (Aug. 15, 1961).

Starting from the Mandelstam representation, it is argued on physical grounds that "strips" along the boundaries of the double spectral regions are likely to control the physical elastic scattering amplitude for arbitrarily high energies at small momentum transfers. Pion–pion scattering is used as an illustration to show how the double spectral functions in the nearest strip regions may be calculated, and an attempt is made to formulate an approximate but "complete" set of dynamical equations. The asymptotic behaviour of the solutions of these equations is discussed, and it is shown that if the total cross-section is to approach a constant at large energies then at low energy the S-dominant $\pi\pi$ solution is inadmissible. A principle of "maximum strength" for strong interactions is proposed, and it is argued that such a principle will allow large low-energy phase shifts only for $l \leq l_{max}$, where $l_{max} \sim 1$.

12055 MULTICHANNEL EFFECTIVE RANGE THEORY. M.H.Ross and G.L.Shaw.
Ann. Phys. (USA), Vol. 13, No. 2, 147-86 (May, 1961).

Effective-range theory is developed for systems of many coupled two-body channels with angular momenta l_i. Derivative of the amplitudes M_{ij} (where M is essentially the inverse of the K matrix) are formed. Quite in analogy with one-channel effective range theory, the diagonal M_{ii} are accurately given, by an expression quadratic in the momentum k_i. The coefficients R_{ij} of k_i^2 are effective-range type integrals which are interpretable in terms of the range of forces and can be taken to be energy independent to the same extent as in the one-channel theory. The non-diagonal elements are, to a good approximation, energy independent, even for R_{ij} greatly different from R_{jj} and $l_i \neq l_j$. The case of two coupled channels is studied in detail: a computer experiment was performed to test the validity of the theory; for $l = 0$, the properties of narrow resonances including the interactions which can lead to them are thoroughly investigated. The positions of the poles of the T matrix are briefly considered. Comparison is made between the effective-range type of parametrization and Breit–Wigner theory. The present theory is contrasted to the effective-range theory for the eigenphase shifts; the eigenphase-shift theory is shown, in principle, to be highly accurate. Some possible applications are briefly discussed.

2056 ANGULAR DISTRIBUTION IN MULTIPLE PROCESSES. B.T.Vavilov.
. Akad. Nauk SSSR, Vol. 137, No. 1, 51-3 (March 1, 1961).
ıssian.
For abstract, see Abstr. 7209 of 1961. [English translation ›oviet Physics — Doklady (USA), Vol. 6, No. 3, 216-18 (Sept.,]].

2057 THE ENERGY PARAMETER IN THE DISPERSION RELATION. G.Mohan.
'o Cimento (Italy), Vol.20, No.1, 205-7 (April 1, 1961)
It is shown that, if the incoming and outgoing target particles different masses, the dispersion relation in the usual matic energy parameter is either without physical content or)btainable. An appropriate parameter for the single variable tion is obtained in the case when all four masses involved in a particle collision may be different. I.J.R.Aitchison

12058 ANALYTIC PROPERTIES AND RESCATTERING CORRECTION TO THE BORN APPROXIMATION t TRANSITION MATRIX ELEMENTS. B.Bosco.
s. Rev. (USA), Vol. 123, No. 3, 1072-6 (Aug. 1, 1961).
The analytic properties of a matrix element of a general rator between a bound state and a scattering state are studied he framework of Schrödinger theory. It is shown that the gularities of such a matrix element are easily inferred from se of the Born approximation. Finally, using the fact that the sible singularities which are not contained in the Born approxi-tion are located far apart from those included in the lowest roximation, a simple formula is derived which allows one to ain the re-scattering correction to the Born approximation using phase shifts explicitly.

12059 ANALYTICITY OF AMPLITUDES AND SEPARABLE POTENTIALS. A.N.Mitra.
ys. Rev. (USA), Vol. 123, No. 5, 1892-5 (Sept. 1, 1961).
Expressions for the partial scattering amplitudes from non-al separable potentials are written down in the form of dispersion ations. These relations are automatically expressible in the N/D m discussed by Chew and Mandelstam (Abstr. 13019 of 1960). iteria for "acceptable" separable potential shapes are discussed. e relation between "local" and separable potentials is clarified h the help of a concrete potential shape which conforms to the ve criteria. With such a potential shape the physical meaning of "range of the interaction" in terms of separable potentials comes clearer. As an elementary application of such "analytic" entials, the low-energy two-body parameters are evaluated.

12060 SUBTRACTIONS IN DISPERSION RELATIONS. M.Sugawara and A.Kanazawa.
ys. Rev. (USA), Vol. 123, No. 5, 1895-1902 (Sept. 1, 1961).
The following theorem is proved: if an analytic function f(z) singularities only on the real axis and is bounded in magnitude infinity by a finite but arbitary power of z, then f(z) has essent-ly the same limits everywhere at infinity. This theorem enables to express the contribution from the infinite circle of the uchy contour integral in terms of the boundary values of f(z) at inity along only one of the cuts extending to infinity. The exact persion relation is thus determined. As examples, the forward double pion—nucleon dispersion relations are determined, suming that the total cross-section approaches a finite limit at inite energy. It is seen how the subtractions are determined mpletely by the theorem.

12061 NEW ANALYSES OF ANOMALOUS IMAGINARY PART. J.Otokozawa.
ogr. theor. Phys. (Japan), Vol. 25, No. 2, 277-89 (Feb., 1961).
Using a new method of analytic continuation and a knowledge of rameter integration, the anomalous imaginary part of the scatte-g amplitude is written explicity with the absorptive part (con-ning t) of the matrix element which connects initial or final te and intermediate state. The meaning of the intermediate state clarified. In the case of pion—deuteron scattering, all the singul-ties are determined. It is confirmed that these singularities ree with those obtained by performing the direct parameter inte-ation of the fourth-order diagram.

12062 INTEGRAL REPRESENTATION OF ABSORPTIVE PART OF VERTEX FUNCTION. K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 361-8 (March, 1961).
On the basis of the Lorentz invariance, local commutativity and mass spectral conditions, it is shown that the absorptive part of the vertex function $A(z_1,z_2,\sigma^2)$ has an integral representation of the form

$$A(z_1,z_2,\sigma^2) = \int dm_1 dm_2 dm_3 \varphi(\sigma,m_1,m_2,m_3)\, A^P(z_1,z_2,\sigma^2;\ m_1,m_2,m_3),$$

provided that z_1 and z_2 are real negative, where A^P is that of the lowest-order perturbation theory and m_i is the mass of the virtual particle. The vanishing region of the weight function φ is determined by the mass spectral conditions. As an immediate consequence of this representation, the usual proof of the dispersion relation of the vertex function is given. Adding the information derivable from the perturbation theory to this representation, one can say that the dispersion relation always holds and the threshold is not lower than the lowest threshold of the vertex function in the lowest-order perturbation theory which satisfies the mass spectral condition. It is suggested that Jost's example (Abstr. 10611 of 1959) has not this integral representation. Finally it is conjectured that the non-vanishing region of the weight function is narrowed by introducing conservation of the nucleon number.

12063 TRANSITION AMPLITUDES IN PERTURBATION THEORY AND DYSON'S INTEGRAL REPRESENTATION. G.Konisi and K.Yamamoto.
Progr. theor. Phys. (Japan, Vol. 25, No. 3, 461-6 (March, 1961).
It is shown that Dyson's integral representation (Abstr. 5654 of 1958) for the matrix element of a causal commutator between the vacuum and an arbitrary state is closely related to the transition amplitude in the lowest order of perturbation. This relation is used to clarify the physical meaning of the parameters of integration. The integral representation for the absorptive parts of vertex functions (see preceding abstract) comes out as a simple example. It can be applied also for the absorptive parts of scattering amplitudes, in which case, however, the simple connection with perturbation theory as with vertex functions is not obtained.

12064 SOLUBLE EXAMPLES IN FIELD THOERY WITH FERMI INTERACTIONS. Y.Ataka.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 369-80 (March, 1961).
A soluble example in field theory with Fermi interaction is proposed. The two fermion fields N and $\bar{N}$ interact as $N + \bar{N} \rightleftharpoons N + \bar{N}$. It is shown that the limit of Machida's soluble model (Abstr. 7964 of 1956), in which the probability amplitude for a bare meson identically vanishes, coincides with this model with the separable form factors. This model with general form factors and another model are discussed.

12065 PHASE SHIFT AND IDENTITIES IN QUANTIZED FIELD THEORY. S.Azuma.
Progr. theor. Phys. (Japan), Vol.25, No. 3, 381-403 (March, 1961).
Certain basic relations between phase shifts and the energy spectrum are pointed out and illustrated by simple examples. Several applications of these relations are considered: a determinant form for the S-matrix is found; n-body forces in the static pair-coupling theory are evaluated; some properties of the g-derivative of the phase shift are discussed and a covariant method for the construction of the nuclear force is proposed.

12066 DISPERSION RELATIONS AND HIGH ENERGY LIMITS IN QUANTUM FIELD THEORY. II. S.Aramaki.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 404-10 (March, 1961).
For Pt I, see Abstr. 20075 of 1960. The lower and upper bounds of the high-energy limit of pion—nucleon forward-scattering amplitudes are investigated. The former is studied using available experimental data and it is found that at least one subtraction is necessary in the dispersion relations. The latter can be determined under an additional requirement that the forward amplitude has no zero in the complex energy plane. Some problems in high-energy behaviour in quantum field theories are discussed.

12067 PION THEORY OF NUCLEAR FORCES AND LOW ENERGY P-WAVE PHASE SHIFTS.
S.Otsuki, M.Taketani, R.Tamagaki and W.Watari.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 427-35 (March, 1961).
It is shown that the low-energy behaviour of the triplet P-wave phase-shifts in proton—proton scattering below 20 MeV, after being corrected for vacuum polarization effect, relativistic effects and for the effect of coupling with the F-wave, confirms the existence of the repulsive central tail of the one-pion-exchange potential.

12068 PION–PION INTERACTION AND NUCLEAR FORCES. Y.Fujii.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 441-60 (March, 1961).

Nuclear potentials arising from the pion–pion resonance in the state I = J = 1 are calculated. Only the part proportional to $\tau\tau$ is considered. The resonant state is described both in the ρ-meson formalism and in the chain approximation method. The potentials are calculated explicitly in configuration space, at first in the ρ-meson formalism with its mass 600 MeV and the strength of coupling which corresponds to the width ~60 MeV. The potentials are found to be of the nature of the two-pion exchange potentials. In particular there appear a strong attractive L-S potential and a repulsive central potential in the ^{3}O-state, a strong repulsive tensor potential in the ^{3}E-state, and a repulsive L-dependent potential in the ^{1}E-state. Among these the tensor potential in the ^{3}E-state and the central potential in the ^{3}O-state can be considered to be too strong and violate some of the facts which have already been established. A careful examination of the results will therefore offer a test for or against the assumption of the pion–pion resonance. The chain approximation method gives similar results. The electromagnetic form factors of the nucleon are re-examined and a discussion is given concerning future investigation.

12069 COLLECTIVE CORRELATION BETWEEN VACUUM NUCLEONS IN PS–PS MESON THEORY. O.Hara.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 472-82 (June, 1961).

The effect of the collective correlation between vacuum nucleons is calculated using an approximation in which the kinetic energy of the nucleons is neglected as compared with their rest energy. The point is that there can exist a strong collective correlation between vacuum nucleons just as between electrons in metal, since interactions between vacuum nucleons due to pions is dominantly attractive. It is shown that this effect can play in fact an important role, if this attractive interaction is sufficiently strong, and that the low-energy behaviour of the phase shift δ_3 of the S-wave pion–nucleon scattering and the position of the (33) resonance are rather sensitive to this effect. As an example, the phase shift δ_3 is calculated using a Tamm-Dancoff approximation including up to two pions and one nucleon–antinucleon pair. It is shown that the result agrees reasonably well with experiment if parameters specifying the strength and the range of the attractive potential are chosen suitably.

TRIPLET P-WAVE PHASE-SHIFTS IN p–p SCATTERING BELOW 20 MeV. See Abstr. 12067

12070 EFFECTIVE INTERACTION IN NUCLEAR MANY-BODY PROBLEM. M.Yasuno.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 411-26 (March, 1961).

A general treatment of the nuclear many-body problem is given in terms of Green's functions, and the correlation property of the nucleus is exhibited by a correlation factor. Effective interaction modifying the independent particle motion is introduced and proved to be identical with Brueckner's K-matrix. On applying the method of the particle–hole pair to the system, a collective mode is derived and the effective interaction contributing to collective motion is studied. It is also shown that this effective interaction has very different properties from the electron plasma case.

APPLICATION OF NUCLEON–NUCLEON DISPERSION RELATIONS TO NUCLEAR MANY-BODY PROBLEM.
See Abstr. 12143

ELEMENTARY PARTICLES

12071 NEW HEAVY BOSONS. H.Fröhlich.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1223 (June, 1961).

The four heavy bosons predicted by the author's wave equation (see Abstr. 464, 5822 of 1961) have exactly the isospin behaviour of the "schizoids" of Lee and Yang. J.E.Paton

12072 POSSIBLE EQUATION OF MOTION OF QUANTUM PARTICLES ALONG A TRAJECTORY. H.P.Dishkant.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 122 (1959). In Ukrainian.

Photons

12073 TRANSFER OF HELICITY IN RADIATION AND ABSORPTION OF HIGH-ENERGY PHOTONS. R.H.P
Phys. Rev. (USA), Vol. 123, No. 4, 1508-10 (Aug. 15, 1961).

Nearly complete transfer of momentum between a high-ene electron (or positron) and a photon in a Coulomb field implies th helicity is also transferred. This is not a consequence of conse vation of total angular momentum but, rather, of spin angular momentum, and follows from a demonstration that it is possible use free-particle spinors (though not free wave-functions) for th high-energy particles. Polarization correlations of the lower energy particle in such a process are discussed. Applications a made to bremsstrahlung, pair production, photoeffect, and one-photon pair annihilation.

12074 A MONOENERGETIC PHOTON BEAM OF VARIABL ENERGY PRODUCED BY THE ANNIHILATION OF POSITRONS IN FLIGHT. J.Miller, C.Schuhl, G.Tamas and C.T
J. Phys. Radium (France), Vol. 21, No. 10, 755-6 (Oct., 1960). In French.

Describes the production of a monochromatic photon beam utilizing the 30 MeV electron linear accelerator at Saclay. The yield of γ-rays is expressed as $N_\gamma = 5.3 \times 10^{-9} N_e$, where N_e is number of incident electrons (it was 15 μa in the measurement described). A 1 mm thick Li target was used to produce the ph by annihilation of monoenergetic positrons produced from the primary electron beam in a Pt target. The beam is used for ph nuclear studies. R.H.Th

12075 CAPABILITIES OF LITHIUM DRIFTED p–i–n JUNCTION DETECTORS WHEN USED FOR GAMMA RAY SPECTROSCOPY. N.A.Bailey, R.J.Grainger and J.W.May
Rev. sci. Instrum (USA), Vol. 32, No. 7, 865-6 (July, 1961).

The use of p–i–n silicon junctions as detectors of β and γ radiations was previously described by Bailey and Mayer [Radi logy (USA), Vol. 76, 116 (1961)]. Here they are used with a 100-channel pulse height analyser to obtain γ-ray spectra. Spe obtained from Cs^{61}, I^{131}, and I^{137} had the expected characteristic S.J.Gold

ACCURACY OF A SCINTILLATION γ-RAY SPECTROMETE
See Abstr. 12183

12076 EXPERIMENTAL STUDIES ON CERENKOV RADIATION. A.Murai and S.Mito.
Mem. Fac. Engng Osaka City Univ. (Japan), Vol. 1, 47-56 (Dec., 1961).

Cherenkov radiation was produced in titanium oxide (dielec constant 100) by passing over its surface a 5 mA electron beam modulated at 9.6 Gc/s. The titanium oxide was in a 24 Gc/s wa guide and coherent radiation with a maximum power of 10^{-7} W v observed with beam voltages from 3.1 to 5.0 kV. The authors consider other possible sources of the radiation than the Chere effect, but conclude that these cannot be responsible for the res obtained. J.L.Re

Electrons

12077 THEORETICAL DISCUSSION OF POSSIBLE EXPER MENTS WITH ELECTRON–POSITRON COLLIDING BEAMS. N.Cabibbo and R.Gatto.
Nuovo Cimento (Italy), Vol. 20, No. 1, 185-93 (April 1, 1961).

Two aspects of high-energy $e^+ + e^-$ experiments are discu (a) the exploration, at time-like momentum transfers, of the fo factors of strongly interacting particles, and (b) the Panofsky programme to investigate the mass spectrum of elementary particles and certain unstable states through their interactions photons. For (a), expressions for the differential cross-sectio for the processes $e^+ + e^- \to f + \bar{f}$, $\to b + \bar{b}$, $\to B + \bar{B}$, are calcula from perturbation theory, to first order in e, in terms of the electric and magnetic form factors of the particles f (charged neutral, spin $\frac{1}{2}$, fermion), b (charged or neutral, spin-zero, bos and B (neutral or charged, spin 1, meson). The fermion polari tion in $e^+ + e^- \to f + \bar{f}$ is also calculated. The magnitudes of t

:ross-sections are estimated in lowest order perturbation
e γ and compared with that for $e^+ + e^- \to \gamma + \gamma$. For (b), the
ole detection of the following resonant states and particles is
ssed: (1) the (T = 1, J = 1) $\pi-\pi$ resonance (in $e^+ + e^- \to \pi^+ + \pi^-$
$^+ + e^- \to \pi^0 + \gamma$); (2) the (T = 0, J = 1, charge conjugation
er C = −1) meson ρ_0 proposed by Nambu (in $e^+ + e^- \to \rho_0 \to$
n state); (3) the semi-weakly interacting boson B, suggested
ediating weak interactions, and the semi-weakly coupled B^0
sonances in $e^+ + e^- \to e^+ + e^-, \to \mu^+ + \mu^-, \to \pi^+ + \pi^-$).

I.J.R.Aitchison

CHRÖDINGER EQUATION FOR A RADIATING ELECTRON.
bstr. 11707

2078 BACK SCATTERING OF ELECTRONS.
G.D.Archard.
pl. Phys. (USA), Vol. 32, No. 8, 1505-9 (Aug., 1961).
The behaviour of a stream of electrons penetrating a solid
et is studied with a view to determining the proportion which
rn to the surface and pass back into space. Two existing
ries (diffusion and large-angle single elastic scattering) are
ted to this end. These theories predominate for high and low
ic numbers, respectively. A combination of the two theories
es well with experiment.

2079 INELASTIC ELECTRON–DEUTERON SCATTERING AND THE ELECTROMAGNETIC STRUCTURE OF THE
TRON. L.Durand, III.
s. Rev. Letters (USA), Vol. 6, No. 11, 631-4 (June 1, 1961).
Reanalysis of data using a covariant dispersion relation
coach, one-nucleon pole approximation, and estimating correct-
. The results give the outer part of the neutron more nearly
ral than previous analysis, and also modify F_{2n}.

J.E.Paton

12080 INELASTIC ELECTRON–DEUTERON SCATTERING CROSS-SECTIONS AT HIGH ENERGIES. II. FINAL-
TE INTERACTIONS AND RELATIVISTIC CORRECTIONS.
urand, III.
s. Rev. (USA), Vol. 123, No. 4, 1393-1422 (Aug. 15, 1961).
For Pt I see Abstr. 350 of 1960. Measurements of the cross-
tion $d^2\sigma/(d\Omega_e dE_e')$ for the inelastic electron–deuteron
ttering process e + d → e + n + p were used to determine the
ctromagnetic structure of the neutron. The effects on the
oretical cross-section of interactions between the outgoing
leons are examined in detail using the methods of a previous
er. The transition matrix elements connecting the initial state
he two-nucleon system (the deuteron) to a final state with
cified total, orbital, and spin angular momenta are calculated
ng approximate wave-functions which are matched to the
erimentally determined neutron–proton scattering phase shifts.
ile individual matrix elements may be drastically changed by the
tortion of the final-state wave-functions by the neutron–proton
eraction, the over-all corrections to the peak value of the
ss-section are found to be small (−1 to −2%) for electron
mentum transfers in the range q = 3.4 – 2.6 f^{-1}. The precise
gnitude of the corrections is somewhat uncertain because of the
roximate nature of the wave-functions, but it is unlikely either
t they are large, or that the corrections could become positive.
e effects of final-state interactions on the cross-section
$/(d\Omega_e dE_e')$ are also examined for final electron energies near
upper limit of the inelastic continuum. In this region, the
leons emerge with low relative momenta, and, in agreement with
predictions of Jankus (1956), the cross-section is found to be
stically changed by the strong interactions in the final S states.
wever, it is shown that the presence in the neutron–proton
eraction of a strongly repulsive core results in a considerable
inution of the cross-section relative to the predictions of
kus for large values of q. This lowering of the cross-section
been observed by Kendall et al. (1960). Results obtained with
roximate repulsive core wave-functions provide a reasonable fit
h to the inelastic cross-section near the end point, and to the
teron electromagnetic form factor obtained from elastic electron–
teron scattering. Finally, the relativistic theory of inelastic
ctron–deuteron scattering is examined using the methods of
persion relations. It is found that in the region of the large peak,
cross-section $d^2\sigma/(d\Omega_e dE_e')$ is given essentially correctly by a
relativistic calculation using a modified Hamiltonian, provided
results are interpreted correctly with respect to the kinematics.
e approximations inherent in the calculation are examined in
ail. The resulting cross-section differs significantly from the
modified Jankus cross-section which has been used in the analysis of the high-energy electron–deuteron scattering data obtained by the Stanford group. It is found that the apparent values of the neutron charge form factor F_{1n} are reduced essentially to zero for q^2 in the range $5f^{-2} \leq q^2 \leq 20f^{-2}$ when relativistic corrections, the effects of the deuteron D-state scattering, and the effects of final-state interactions are taken into account. Corresponding reductions in the value of the neutron anomalous magnetic moment form factor F_{2n} range up to about 30%, and bring F_{2n} into closer agreement with F_{2p}. A complete re-analysis of the experimental data will be necessary.

12081 ELECTRON–ELECTRON SCATTERING AT 500 MeV.
E.B.Dally.
Phys. Rev. (USA), Vol. 123, No. 5, 1840-50 (Sept. 1, 1961).
The electron–electron differential scattering cross-section was measured using a 500 MeV electron beam from the Stanford Mark III linear electron accelerator. Deviations were sought fro the theoretical cross-section as calculated in first-order perturb - tion theory (Møller scattering). The experimental results were compared with the Møller formula as corrected to the next order in perturbation theory by the work of Tsai. Atomic electrons in a beryllium target foil constituted the target for the electron–electron scattering. The scattered electrons passed through a slit system which defined the angle of scattering and the solid angle. After the particles passed through the slit system, they entered a double-focusing magnetic spectrometer, which analysed the scattered particles in momentum. The electrons emerging from the spectrometer were detected by a liquid Cherenkov counter. The incident beam was monitored with the use of a Faraday cup and an electronic current integrator. In order to enhance the accuracy of the experiment, the experimental electron–electron scattering was compared to the elastic electron scattering from the target nuclei (Mott scattering). The cross-section was measured af approximately 2.6, 3.5, and 4.5 deg in the laboratory system. These angles correspond to approximately 90, 107, and 120 deg in the centre-of-mass system, respectively. The theoretical magnitude of the radiative corrections is −5.5, −4.9, and −4.9% for the scattering angles 2.6, 3.5, and 4.5 deg, respectively. The average experimental deviation from the Møller formula found for the above angles was −3.0 (±2.3)%, −3.5 (±2.9)%, and −5.9 (±2.3)%, respectively, where the error cited is total statistical error. In addition to the statistical error there is a maximum estimated ±2% possible systematic error.

POSITRONIUM GROUND STATE: APPROXIMATE SOLUTION OF THE BETHE–SALPETER EQUATION.
See Abstr. 12050

Nucleons

12082 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON AND THE COMPOSITE MODEL FOR PION.
C.Ihara.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 229-34 (Feb., 1961).
The electromagnetic structure of the nucleon is investigated on the basis of the composite model for the pion. The mean square radius of charge distribution of the nucleon is calculated by the second-order perturbation and the same coupling constants are u ed as those in the calculation (Abstr. 13024 of 1960; 3215 of 1961) of the pion–nucleon interaction and the anomalous magnetic moment of the nucleon in this model. The results are qualitatively in agreement with experiment and it is possible to explain all these phenomena consistently from the standpoint of the composite model.

12083 SEPARATION OF HIGH-ENERGY PARTICLES BY MEANS OF STRONG INTERACTIONS.
G.Goldhaber, S.Goldhaber and B.Peters.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 502-10 (June, 1961).
A method is discussed by which nucleons and pions emitted from an accelerator target can be eliminated preferentially so that one obtains beams which consist mainly of antinucleons and K-mesons. The method which is applicable to relativistic particles is not confined to the range of energies which are available in the laboratory at present. At the CERN proton synchrotron secondary-particle production is sufficiently high to make such separated beams of antinucleons and K-mesons useful for bubble chamber work up to particle momenta well above 8 GeV/c.

Protons

12084 A SEMIPHENOMENOLOGICAL PROTON–PROTON POTENTIAL. T.Hamada.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1033-48 (Nov., 1960).

An energy-independent potential is constructed which reproduces all available p–p data up to 310 MeV. At 310 MeV the potential predicts the phase shift solution 1 of MacGregor et al (Abstr. 2543 of 1960). The potential includes the central, tensor, linear and quadratic LS potentials. The quadratic LS potential is manifestly required in the singlet even parity state where the linear LS potential vanishes. The linear LS potential turns out to be more singular but of shorter range than previously thought. It appears now that the p–p data below 310 MeV can be understood in terms of a potential consistent in all respects with the pion theory of nuclear forces. See also following abstract.

12085 A SEMIPHENOMENOLOGICAL NEUTRON–PROTON POTENTIAL. T.Hamada.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 247-58 (Feb., 1961).

A T = 0 two-nucleon potential is found which, when combined with the T = 1 potential (see preceding abstract), can reproduce all experimental neutron–proton data below 300 MeV. The triplet even-parity potential is not strictly energy independent. The required energy dependence is, however, very small and confined in the core region. In the triplet even-parity state, it is found that both linear and quadratic LS potentials are required. The linear LS potential is weak and repulsive. The quadratic LS potential is here stronger than that required in the T = 1 state and it is attractive. The singlet odd-parity potential is slightly more repulsive than that of the one-pion-exchange potential. It is concluded that all two-nucleon data up to 300 MeV can be understood in terms of a potential picture which is consistent with the current implications of the pion theory of nuclear forces.

12086 PROTON–PROTON INTERACTION.
H.Feshbach, E.Lomon and A.Tubis.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 635-8 (June 1, 1961).

A precision fit up to 350 MeV, using an energy-independent boundary condition model, one- and two-pion tails and nine additional parameters. J.E.Paton

12087 RELATIVE INELASTICITY AND ANISOTROPY OF PROTON INTERACTIONS AT 9 AND 23.5 GeV.
E.M.Friedländer, M.Marcu and M.Spîrchez.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 25-7 (July 1, 1961).

Observations of cosmic-ray jets show evidence for a decrease in the inelasticity K of nucleon–nucleon collisions with increasing energy of the primary together with an increase of the forward–backward peaking of the c.m. angular distribution of the secondaries. In order to check this trend under controlled laboratory conditions, emulsion stacks were exposed to the proton beams of the Dubna and CERN proton synchrotrons. Electron pairs from $\pi^0 \rightarrow 2\gamma$ decay were detected and the projected opening angle α and angle θ of the pair bisector with the beam direction were measured. $\langle \alpha^{-1} \rangle$ is proportional to the average energy of the π^0's which when multiplied by their average multiplicity gives a number proportional to the inelasticity of the collision. The result obtained for the relative inelasticities is $K(23.5)/K(9) \leq 0.70 \pm 0.08$. This was checked using the charged secondaries and assuming that their average transverse momentum was independent of emission angle. This method yielded a result of $K(23.5)/K(9) = 0.67 \pm 0.06$, consistent with the first. Observations on the angular distributions of the secondary particles showed that there was appreciable forward–backward peaking in the c.m. system, the peaking being more marked at 23.5 GeV.
J.D.Dowell

12088 AZIMUTHAL SYMMETRY IN 27 GeV JETS.
C. Castagnoli, C. Lamborizio, I. Ortalli and A. Barbaro-Galtieri.
Nuovo Cimento (Italy), Vol. 20, No.2, 416-18 (April 16, 1961)

A search was made for azimuthal asymmetry in jets produced in nuclear emulsion by 27 GeV protons from the CERN proton-synchrotron. Measurements on 142 jets showed no significant deviation from symmetry. A.Ashmore

12089 VERIFICATION AT 27 GeV OF A FORMULA FOR T DETERMINATION OF THE PRIMARY ENERGY OF JETS. A.B.Galtieri, G.Baroni, A.Manfredini, C.Castagnoli, C.Lamborizio and I.Ortalli.
Nuovo Cimento (Italy), Vol. 20, No. 3, 487-97 (May 1, 1961).

Proton interactions in nuclear emulsions at 27 GeV are analysed in order to verify at this energy the validity of the formula $\log \gamma_c \approx \langle |\log|\cot\theta|| \rangle$. Good agreement between expect and experimental values is found for interactions with $N_h \leq 4$ a $n_s \simeq 4$. The correction to be introduced under the hypothesis o pion spectrum due to statistical theory is discussed, as well as the dispersion of the value of $\log \gamma_c$ obtained.

Neutrons

5 BeV NEUTRON CROSS SECTIONS IN HYDROGEN AND OTHER ELEMENTS. See Abstr. 12206

12090 THE ANALYSIS OF S-WAVE NEUTRON RESONANC IN TIME-OF-FLIGHT EXPERIMENTS.
C.Corge, J.Julien and F.Netter.
J. Phys. Radium (France), Vol. 21, No. 10, 759-60 (Oct., 1960).
In French.

12091 CONICAL TWO-CRYSTAL MONOCHROMATOR FO SCATTERING, DIFFRACTION, AND ABSORPTION CROSS-SECTION WORK WITH SLOW NEUTRONS. K.Das Gupt
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 602-3 (May, 1961).

Two NaCl crystals, $5 \times 2 \times 0.1$ cm^3 in the (200) plane, wer bent cylindrically (20 cm diam) and conically (5° semivertical angle and mean diameter 16 cm) to form a two-crystal monochr mator for 0.34 eV ($\equiv$ 0.49 A) neutrons. The annular aperture wa about 5 cm^2 and the area for the scattering specimen was about 3 cm^2. E.T.B

Mesons

12092 MESONS AND HYPERONS.
G.A.Snow and M.M.Shapiro.
Rev. mod. Phys. (USA), Vol. 33, No. 2, 231-8 (April, 1961).

Gives the intrinsic properties and decay modes of the parti together with brief descriptions of the methods used to obtain th information. 144 refs. J.L.Re

MESONS AS VECTOR FIELDS IN THE UNITARY THEORY OF THE SAKATA MODEL. See Abstr. 12047

NUCLEAR DE-EXCITATION FOLLOWING MUON CAPTUR AND THE BOUND MUON DECAY ANOMALY. See Abstr. 122

12093 HELICITY OF μ^- MESONS; MOTT SCATTERING O POLARIZED MUONS. M.Brandon, P.Franzini and J
Phys. Rev. Letters (USA), Vol. 7, No. 1, 23-5 (July 1, 1961).

The purpose of the experiment was to observe the helicity the μ^--meson from π-meson decay, $\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$, and therefore establish the helicity of the associated ν_μ. Counters were used measure the left–right asymmetry arising from spin–orbit coupling in the Mott scattering of a transversely polarized (90% μ^--beam. The measured asymmetry $(L - R)/(L + R)$ was -0.090 ± 0.031, in agreement with a predicted value of -0.09 fo a positive (right-handed) μ^--meson helicity. Thus the antineutr is also right-handed and therefore has the same helicity as the $\bar{\nu}$ from β^--decay. Careful precautions were taken to eliminate systematic effects which could have simulated an asymmetry. result is in agreement with those obtained from polarized μ–e scattering in magnetized iron and supports the V–A theory.
J.D.D

12094 CONVERSION OF MUONIUM INTO ANTIMUONIUM.
G.Feinberg and S.Weinberg.
Phys. Rev. (USA) Vol. 123, No. 4, 1439-43 (Aug. 15, 1961).

A detailed analysis is made of the possible conversion of muonium into antimuonium in various environments. An assumed $\bar{\mu}_e \mu_e$ weak interaction of the usual form and strength gives a prob bility of 2.5×10^{-5} in vacuum, even in the presence of reasonable ex

ic fields. In a solid the probability is less by at least 10, robably 20, orders of magnitude. In an inert gas the bility is roughly to be divided by the numbers of collisions g a muon lifetime, and hence is quite small unless the pressure om temperature is less than about 10^{-4} atm. Lowering the erature does not help. A possible experiment is suggested.

095 HIGH ENERGY NUCLEAR PHYSICS. W.O.Lock.

on: Methuen; New York: John Wiley (1960). xi + 190 pp.
The book is intended as an introduction to pion physics. It is d on a series of postgraduate lectures and assumes, there- an elementary knowledge of quantum mechanics. Topics red include; photoproduction of pions; pion production by eons; nucleon–nucleon and nucleon–complex nucleus inter- ns in the energy range above 100 MeV. An index is provided.

2096 RADIATIVE CORRECTIONS TO PION PRODUCTION IN e^+–e^- COLLISIONS. G.Putzolu.

o Cimento (Italy), Vol. 20, No. 3, 542-5 (May 1, 1961).
Radiative corrections to the processes $e^+ - e^- \rightarrow n$ pions are uated in relation to the planned colliding beam experiments. eorem is proved which shows the possibility of separating rimentally the contribution of the γ–n pion vertex from the ribution of the 2γ–n pion vertex.

2097 PHOTOPRODUCTION OF NEUTRAL MESONS IN HELIUM. J.L.Cook.

lear. Phys. (Internat.), Vol. 25, No. 3, 421-30 (June, 1961).
For photon energies above 280 MeV, it is found that the experi- ts for elastic photoproduction of π^0-mesons can be explained in impulse approximation. At lower energies multiple scattering arge and is estimated using the method of Chappelear (Abstr. 4 of 1955). The r.m.s. radius of He^4 is determined, from the eriments at 290 MeV by Palit and Bellamy (Abstr. 1674 of 1959), is found to be 1.5 ± 1 fm, for eight different wave-functions.

12098 PHOTOPRODUCTION OF CHARGED π MESONS FROM NUCLEI. W.M.McClelland.

s. Rev. (USA), Vol. 123, No. 4, 1423-35 (Aug. 15, 1961).
The photoproduction of charged π-mesons by a 1000 MeV msstrahlung beam was studied for the elements Be, C, Al, Cu Pb. Mesons with energies in the range 100 to 4000 MeV erging from the targets at angles of 58° and 115° were detected, absolute measurements for the cross-sections are given. An ical model for the nucleus was employed to predict absolute er and lower limits for the nuclear cross-section, and reasonable eement with the data was obtained. The measured cross-sections l a dependence on the target atomic weight of $A^{3/4}$ and this result between the limits predicted by the model. The experimental clear π^-/π^+ ratio exhibited the general behaviour of this ntity for deuterium, but the model could make no prediction re. The results seem to be consistent with an optical model atment of an assumed initial production of mesons throughout nuclear volume, and no recourse to a surface production chanism was found to be necessary.

12099 PHOTOPION PRODUCTION AND $(\gamma,3\pi)$ INTERACTION. M.Kato.

ogr. theor. Phys. (Japan), Vol. 25, No. 3, 493-507 (March, 1961).
The photoproduction of a neutral pion is investigated to obtain formation on the $(\gamma,3\pi)$ interaction. An amplitude for photo- oduction is obtained in terms of the isovector form factors of the cleon and a coupling constant representing the above interaction. is interaction is found to have a fairly large effect on the gular distribution of the neutral pion production, especially on e coefficient of cos θ. Comparisons with experiment impose a ude limitation on the magnitude of the coupling constant. ference is made to the work of Ball (Abstr. 17401 of 1960).

12100 SELF-CONSISTENT CALCULATION OF THE MASS AND WIDTH OF THE J = 1, T = 1, $\pi\pi$ RESONANCE. Zachariasen.

ys. Rev. Letters (USA), Vol. 7, No. 3, 112-13 (Aug.1, 1961).
The left hand cut is taken as given by exchange of a vector eson whose mass and coupling constant are adjusted to give a nsistent position and width for the resonance, in fair agreement th experiment. J.E.Paton

12101 EVIDENCE FOR PION–PION INTERACTIONS FROM s-WAVE PION–NUCLEON SCATTERING.
J. Hamilton, P.Menotti, T.D.Spearman and W.S.Woolcock.
Nuovo Cimento (Italy), Vol. 20, No. 3, 519-28 (May 1, 1961).
By fitting the s-wave partial amplitudes for π–N scattering, in an unphysical region, the energy range is greatly extended over which the contribution from the process $\pi + \pi \rightarrow N + N$ can be examined. The method shows up contributions from this process in states of isotopic spin T = 0 and T = 1. The energies $t^{1/2}$ for which this process is important can be estimated. The form of these contributions is just what would be expected from considerations of angular momenta. Estimates of the amplitudes for $\pi + \pi \rightarrow N + \bar{N}$ are deduced. The T = 0 amplitude is large, but in the T = 1 case the amplitude is much smaller than the values which have been predicted from the nucleon isovector form factors.

12102 PION–PION INTERACTION IN PION PRODUCTION BY π^+–p COLLISIONS.
D.Stonehill, C.Baltay, H.Courant, W.Fickinger, E.C.Fowler, H.Kraybill, J.Sandweiss, J.Sanford and H.Taft.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 624-5 (June 1, 1961).
Results are given of a systematic study of pion–pion reactions at energies of 910, 1090, and 1260 MeV. From the distribution of Q values of the two outgoing pions in the single-pion production processes the authors conclude that the interaction responsible for the observed peaks is overwhelmingly in the state I = 1, consistent with theoretical preditions. In addition, an approximate estimate gives a pion–pion resonance energy of the order of 5 pion masses. J.H.Gunn

PION–PION INTERACTION AND NUCLEAR FORCES.
See Abstr. 12068

12103 EVIDENCE FOR π–π RESONANCE IN THE I = 1, J = 1 STATE.
A.R.Erwin, R.March, W.D.Walker and E.West.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 628-30 (June 1, 1961).
An experiment was designed and carried out to explore the π–π system up to an energy of about 1 BeV. The combined angular distribution for the nucleons from the two processes, $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ and $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ is shown. The events with small momentum transfer to the nucleon, which satisfy the qualitative criterion of being examples of π–π collisions, are discussed. F.Herbut

12104 SIGMA DECAY MODES OF PION–HYPERON RESONANCES. P.Bastien, M.Ferro-Luzzi and A.H.Rosenfeld.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 702-5 (June 15, 1961).
An analysis of the reactions $K^- + p \rightarrow \Sigma + \pi + \pi$ yields a value of 2 ± 2% for the (Σ/Λ) branching ratio of the decay of the Y_1^* resonance. Weak evidence for an isospin zero Σ–π resonance is also presented. J.E.Paton

12105 ANGULAR DISTRIBUTION OF PROTONS FROM π^-–p SCATTERING AT 900 MeV.
B.C.Maglić, B.T.Feld and C.A.Diffey.
Phys. Rev. (USA), Vol. 123, No. 4, 1444-51 (Aug. 15, 1961).
The shape of the π^-–p differential scattering cross-section in the backward hemisphere should be sensitive to the nature of the "resonances" assumed to be responsible for the peaks in the total cross-section at 600 and 900 MeV. The angular distribution of protons scattered in the forward hemisphere by pions of kinetic energy around 925 MeV, corresponding to pion c.m. angles from 65 deg to 150 deg, was obtained by placing nuclear emulsions close to liquid hydrogen and by measuring the direction angle and the grain count of every proton track. It is shown that the sensitivity of emulsions in the temperature region $22^\circ K \leq T \leq 90^\circ K$ does not drop below 85% of the sensitivity at 300° K. The resulting distribution is consistent with the assignment of $D_{3/2}^{1/2}$ and $F_{5/2}^{1/2}$, respectively, for the 600 and 900 MeV levels.

12106 s-WAVE PION–NUCLEON SCATTERING. J.L.Uretsky.
Phys. Rev. (USA), Vol. 123, No. 4, 1459-64 (Aug. 15, 1961).
The Mandelstam relations for pion–nucleon scattering are used to obtain equations for the s-wave partial amplitudes in the two isotopic spin states. The solutions of these equations are investigated in the approximation where only the one-nucleon contributions and the unitarity integral are kept. It is found that there are no solutions of the form N/D without complex zeros, and that this is a consequence of the large size of the one-nucleon terms. A comparison with experiment is made which suggests that the dominant

contribution to the $T=\frac{3}{2}$ s-wave amplitude (other than the one-nucleon contribution) comes from a region of the complex energy plane that is outside the physical region for the related processes ($\pi-\pi$ into NN and "crossed" $\pi-N$ scattering). An appendix is devoted to discussing the available experimental data and they are found to be consistent with a scattering length (δ/k at threshold) of 0.098 ± 0.004 in the $T=\frac{3}{2}$ state.

12107 THEORY OF $\pi-N$ SCATTERING IN THE STRIP APPROXIMATION TO THE MANDELSTAM REPRESENTATION. V.Singh and B.M.Udgaonkar.
Phys. Rev. (USA), Vol. 123, No. 4, 1487-95 (Aug. 15, 1961).

The strip approximation to the Mandelstam representation is applied to the $\pi-N$ problem, and the basic equations given. The asymptotic behaviour of the invariant amplitudes in the physical regions is discussed in terms of the unitarity condition on partial-wave amplitudes, the constancy of high-energy scattering cross-sections, and the Pomeranchuk theorem, and it is shown to imply that no subtractions should be necessary except in the $J=\frac{1}{2}$ wave of the $\pi-N$ channel and the $J=0$ wave of the $\pi+\pi \rightarrow N+\bar{N}$ channel. This obviates the difficulties encountered by the earlier workers when they subtracted higher waves.

12108 POSSIBLE MECHANISM FOR THE PION-NUCLEON SECOND RESONANCE. R.F.Peierls.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 641-3 (June 1, 1961).

Treating the 3-3 isobar as a "particle", N*, the amplitudes $\pi+N \rightarrow \pi+N$, $\pi+N \rightarrow \pi+N^*$ and $\pi+N^* \rightarrow \pi+N^*$ are strongly coupled. The one-nucleon crossed pole contribution to the last of these has a resonance-like behaviour at the position of the second resonance of about the experimentally observed width.
J.E.Paton

12109 COUPLED S- AND P-WAVE SOLUTIONS FOR PION–PION SCATTERING. B.H.Bransden and J.W.Moffat.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 708-10 (June 15, 1961).

The results of a numerical iteration of a set of coupled equations derived previously (Abstr. 3220 of 1961) are presented. The pion–pion coupling constant λ is used as a parameter and it is found that for $|\lambda| < 0.45$ a p-wave resonance develops. J.E.Paton

12110 THE ANALYTICITY OF THE SCATTERING AMPLITUDE AND UNITARITY OF THE SCATTERING OPERATOR IN THE $\pi-\pi$ INTERACTION. J.J.Henning.
Z. Phys. (Germany), Vol. 163, No. 2, 211-17 (1961). In German.

The limitations which unitarity imposes on the magnitudes of the residues for the scattering amplitude in an effective-range treatment of pion–pion scattering are investigated.

PION–DEUTERON SCATTERING AMPLITUDE.
See Abstr. 12061

12111 THE PION–PION INTERACTION IN τ-DECAY. E.Lomon, S.Morris, E.J.Irwin, Jr and T.Truong.
Ann. Phys. (USA), Vol. 13, No. 3, 359-78 (June, 1961).

The momentum dependence of the τ decay rate deviates considerably from that predicted by the relativistic phase space factor and Coulomb corrections. The difference is attributed here to the final state pion–pion interaction. Three different phenomenological analyses are made to determine the $T=0$ and $T=2$ s-state pion–pion force required for consistency with τ and τ' data: a scattering length approximation, an independent pair approximation for an exponential potential, and a Born approximation for a Yukawa potential. The results of all three approximations agree where they are applicable and indicate a weak or repulsive $T=0$ force and an attractive $T=2$ force.

12112 PRELIMINARY ANALYSIS OF PHOTOPRODUCTION OF K MESONS IN THE MANDELSTAM REPRESENTATION. Fayyazuddin.
Phys. Rev. (USA), Vol. 123, No. 5, 1882-7 (Sept. 1, 1961).

The analytic properties of individual multipoles are investigated and the positions of the singularities are located.

12113 MODIFIED STATIC EQUATIONS FOR THE $K\pi$-INTERACTION. EFFECT OF PION–PION RESONANCE. B.W.Lee and K.S.Cho.
Nuovo Cimento (Italy), Vol. 20, No. 3, 553-69 (May 1, 1961).

The Cini–Fubini approximate version of the double dispersion representation is reduced to an integral equation in one variable for the $K\pi$-interaction. The resulting equation has the structure of a static theory equation but incorporates the effect of the $\pi+\pi \rightarrow K+\bar{K}$ channel on $K\pi$-scattering and satisfies the condition at the symmetry point prescribed by the relativistic theory. A slight distortion of the crossing matrix renders possible an exact solution to the equation. The nature of the solution is discussed. Construction of the approximate unitary amplitudes for the $K\pi$-interaction which satisfy the crossing relations is discussed in the appendix.

12114 APPLICATION OF THE CHEW AND LOW EXTRAPOLATION PROCEDURE TO $K^- + d \rightarrow Y + n + \pi$ ABSORPTION REACTIONS. J.S.Dowker.
Nuovo Cimento (Italy), Vol. 20, No. 1, 182-4 (April 1, 1961).

An extrapolation of capture-at-rest data to obtain cross-sections below threshold is suggested. Capture of K^--mesons in d and He^4 is proposed as a possible means of distinguishing the Dalitz–Tuan scattering length sets. Other singularities, besides the extrapolation pole, and the momentum dependence of the $He^3 + n \rightarrow He^4$ vertex are briefly considered. J.S.Do

12115 K^-–D ABSORPTION AND A $\pi-\Sigma$ RESONANCE. R.L.Schult and R.H.Capps.
Phys. Rev. (USA), Vol. 122, No. 5, 1659-62 (June 1, 1961).

The branching ratios for the $K^- + d \rightarrow \pi + Y + N$ reactions compared with those for the $K^- + p \rightarrow \pi + Y$ reactions. Certain these deuteron branching ratios are shown to be independent of hyperon–nucleon final-state interaction and are inconsistent w the proton branching ratios. The most likely explanation of the discrepancy is the presence of an isospin zero $\pi-\Sigma$ resonance few MeV below the $K^- + p$ threshold. This resonance is consis with the (b–) set of K^-–p scattering lengths determined by Dali and Tuan (Abstr. 11389 of 1959; 379, 15435 of 1960).

12116 ON THE KK$\pi\pi$ INTERACTIONS. K.Igi.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 201-10 (Feb., 1961

Low-energy K-meson–nucleon interaction is re-investigat under the following assumptions. (1) The K-meson is scattere KK$\pi\pi$ interactions of the isospin independent and dependent typ addition to the direct K-meson–hyperon–nucleon interactions. (2) In the low-energy range (up to 250 MeV), S-wave K–nucleon scattering is dominant. (3) The source of S-wave K-mesons is extended to a comparable size as the potential range via the ex change of two pions. The characteristic features of low-energy K–nucleon scattering are shown to be reproduced under the abo assumptions. It turns out that the KK$\pi\pi$ interaction of isospin dependent type plays an important role in K–nucleon scattering

12117 K-MESON–NUCLEON SCATTERING. M.M.Islam.
Nuovo Cimento (Italy), Vol. 20, No. 3, 546-52 (May 1, 1961).

Assuming that the isotropy of KN-scattering in $I=1$ is due the cancellation of p-wave contributions coming from the hyper cuts and the two-pion cut, the author investigates the KN-scatte in $I=1$, s-state and in $I=0$, $s-$, $p_{3/2}-$, $p_{3/2}$-states. Qualitative agreement with the present experimental situation is obtained. Using crossing symmetry, the two-pion contribution in KN-scattering is also considered.

12118 DISPERSION RELATION ANALYSIS OF P-WAVE K-MESON NUCLEON SCATTERING. W.Alles.
Nuovo Cimento (Italy), Vol. 19, No. 3, 600-4 (Feb. 1, 1961).

The problem is treated by analogy with the $\pi-N$ case, usin CGLN technique. Unsubtracted single variable dispersion rela are written down, and yield dispersion relations for the p-wave amplitudes $h_{T,2J}$. The resulting analytical properties of $h_{T,2J}$ found to give a good approximation to those found from a double dispersion relation, provided the cut due to the reaction $K\bar{K} \rightarrow \pi$ neglected. An effective range formula is derived. The analysis not inconsistent with a $T=0$ KN, $T=1$ $\bar{K}N$ resonance. A $J=\frac{1}{2}$ $J=\frac{3}{2}$ KN resonance appears to be preferred in the case $f_\Sigma^2 < f_\Lambda^2$ while if $f_\Sigma^2 > f_\Lambda^2/3$ a $J=\frac{3}{2}$ KN, $J=\frac{1}{2}$ or $\frac{3}{2}$ $\bar{K}N$ resonance is prefer where f_Σ^2, f_Λ^2 are the respective coupling constants.
I.J.R.Aitc

12119 NUMBER OF K^+ MESONS PRODUCED IN "SATURN J.Teiger.
Nuovo Cimento (Italy), Vol. 19, No. 4, 826-7 (Feb. 16, 1961). In French.

Differential cross-sections are given at 35^0 for incident pr energies between 1.27 and 2.92 GeV and targets of C, Cu, and P For copper measurements were also made at 0.6, 0.7 and 0.8 G A momentum-analysed beam arrangement is described giving 6 per 10^{10} protons on the target. A.Ash

perons

12120 THE NON-LEPTONIC DECAYS OF HYPERONS.
Z.Maki and Y.Ohnuki.
gr. theor. Phys. (Japan), Vol. 25, No. 3, 353-60 (March, 1961).
The non-leptonic decays of hyperons are investigated based on Sakata model (Abstr. 6884 of 1957) and the V—A theory of weak ractions. The Λ-decay and Σ-decay are treated in a unified . In the latter case, a possible interpretation of the experimental lence is given provided that the structure of the Σ-hyperon sfies some suitable conditions.

12121 EVIDENCE FOR LOW RATES FOR β DECAY OF Σ^- AND Λ HYPERONS.
.Humphrey, J.Kirz and A.H.Rosenfeld; J.Leitner and Y.I.Rhee.
s. Rev. Letters (USA), Vol. 6, No. 9, 478-81 (May 1, 1961).
The branching ratios for β-decay of the Σ and Λ hyperons e determined in the Berkeley 15 in. hydrogen bubble chamber, hyperons being produced by K^- capture at rest or at very low rgies. It is found that the decay rates for the reactions $\rightarrow e^- + n + \bar{\nu}$, $\Lambda \rightarrow e^- + p + \bar{\nu}$ and $\Sigma^+ \rightarrow e^+ + n + \bar{\nu}$ are .1%, ~0.2% and ~0% respectively, the discrepancey between ory and experiment being about 10 to 1. S.J.St-Lorant

12122 DETERMINATION OF THE MASS OF THE Λ^0 HYPERON.
Bogdanowicz,M.Danysz, A.Filipkowski, E.Marquit, E.Skrzypczàk, Wróblewski and J.Zakrzewski.
ta phys. Polon. (Poland), Vol. 19, No. 3, 277-87 (1960).
An analysis of 53 $\Lambda^0 \rightarrow p + \pi^-$ decays found in a stack of nulsion exposed to a beam of K^- mesons gives $Q_\Lambda = (37.58 \pm 0.18)$ eV and $M_\Lambda = (1115.42 \pm 0.19)$ MeV. From an analysis of the sults of other laboratories on the standard range of protons om the decay of Σ^+_p hyperons at rest and the results obtained in e calibration of the emulsion used in the present work one tains as the best estimate the value $R_{St} = (1678.6 \pm 3.2)\ \mu$, nich corresponds to $M_{\Sigma^+} = (1189.43 \pm 0.31)$ MeV.

12123 SCATTERING MATRIX APPROACH TO THE Λ—π RESONANCE. K.C.Wali, T.Fulton and G.Feldman.
ys. Rev. Letters (USA), Vol. 6, No. 11, 644-5 (June 1, 1961).
A dispersion theoretical effective-range analysis of scattering the three I = 1 channels, $\bar{K}N$, Σπ, Λπ. If Σ—Λ and Λ—K parities e odd, there can exist an I = 1, J = ½ resonance, and all the own data may be fitted. J.E.Paton

12124 ON THE ELECTROMAGNETIC MASS DIFFERENCES AMONG THE SIGMA HYPERONS. Y.Sugimoto.
rogr. theor. Phys. (Japan), Vol. 25, No. 2, 189-200 (Feb., 1961).
The problem of the mass difference of the triplet sigma is iscussed in terms of an electromagnetic self-energy by taking ccount of the virtual process $\Sigma^0 \rightarrow \Lambda^0 + \gamma \rightarrow \Sigma^0$ and the process $^0 \rightarrow \Sigma^0 + \gamma \rightarrow \Sigma^0$ for the self-mass of the neutral sigma on an equal ooting. The electromagnetic form factor is introduced to serve as cutoff factor. With the e^2-approximation, it can be seen that the rocess $\Sigma^0 \rightarrow \Lambda^0 + \gamma \rightarrow \Sigma^0$ plays an important role in the Σ mass plitting.

12125 CONSEQUENCES OF A SCALAR ΣΛπ COUPLING.
J.Bernstein and R.Oehme.
hys. Rev. Letters (USA), Vol. 6, No. 11, 639-41 (June 1, 1961).
The coupling constant is estimated by calculating the contribu- ion of the Σ pole to S-wave π—Λ scattering, giving $(1/4\pi)\, g^2_{\Sigma\Lambda\pi}$ 1.8. This value is used to estimate the Σ decay rates. J.E.Paton

12126 STUDY OF RESONANCES OF THE Σ—π SYSTEM.
M.H.Alston, L.W.Alvarez, P.Eberhard, M.L.Good, .Graziano, H.K.Ticho and S.G.Wojcicki.
hys. Rev. Letters (USA), Vol. 6, No. 12, 698-702 (June 15, 1961).
An analysis of the reactions $K^- + p \rightarrow \gamma + \pi + \pi$ and $^- + p \rightarrow \gamma + \pi + \pi + \pi$ produces the tentative conclusion of an sospin zero Σ—π resonance at about 1405 MeV with width roughly 0 MeV. J.E.Paton

12127 PRODUCTION OF STRANGE PARTICLES IN p—p COLLISIONS AT 2.85 BeV.
.I.Louttit, T.W.Morris, D.C.Rahm, R.R.Rau, A.M.Thorndike, .J.Willis and R.M.Lea.
hys. Rev. (USA), Vol. 123, No. 4, 1465-71 (Aug. 15, 1961).
From a sample of 98 hyperon production events observed in a liquid-hydrogen bubble chamber the partial cross-sections for various final states are found to be: Σ^+K^+n : 0.047; Σ^+K^0p : 0.030; Σ^0K^+p : 0.013; Λ^0K^+p : 0.051; $\Sigma^-K^+p\pi^+$: 0.003; $\Sigma^+KN\pi$: 0.004; $(\Lambda^0\Sigma^0)K^+p\pi^0$: 0.011; $(\Lambda^0\Sigma^0)K^0p\pi^+$: 0.014; $(\Lambda^0\Sigma^0)K^+n\pi^+$: 0.002; all in millibarns. For the first four processes the values are in general agreement with those calculated by Ferrari using a one-pion-exchange model. Only one example of K-pair production was observed, indicating a cross-section less than 0.01 mb.

Deuterons

12128 MEASUREMENT OF THE DEUTERON BINDING ENERGY USING A BENT-CRYSTAL SPECTROGRAPH.
A.Halim Kazi, C.Rasmussen and H.Mark.
Phys. Rev. (USA), Vol. 123, No. 4, 1310-15 (Aug. 15, 1961).
The deuteron binding energy was determined by measuring the neutron-proton capture gamma-ray energy. This energy was measured directly, relative to annihilation radiation, with the help of a 6 m radius bent-crystal spectrograph. The spectrograph is of the Cauchois type, in which a collimated but extended gamma-ray beam is incident on the convex side of an elastically bent quartz crystal, is diffracted, and is focused onto a focal circle defined by the radius of curvature of the crystal. The neutron-proton capture gamma-rays are produced by placing a polyethylene sample in the through port of the reactor. The (310) planes of quartz are used for diffraction, and the gamma-ray lines are recorded on glass mounted 600μ thick Ilford G-5 emulsions. The value of B(D) obtained is 2225.5 ± 1.5 keV, where the error is the standard deviation. This is the most precise direct measurement reported to date, and is in agreement with previous work. Using recent mass-spectroscopic data, the mass of the neutron is found to be 1.008 984 ± 0.000 002 a.m.u. The efficiency of the spectrograph is low. At 2225 keV, 6000 curie hr is required to record a line; at 511 keV, 1200 curie hr is necessary. The error in B(D) agrees with the estimated precision which varies from about 0.01% at 100 keV to 0.3% at 4000 keV. The latter energy is close to the practical upper energy limit of the instrument.

12129 ANALYTIC PROPERTIES OF DEUTERON PHOTODISINTEGRATION MATRIX ELEMENT FOR FIXED ENERGY. A.Martin.
Nuovo Cimento (Italy), Vol. 19, No. 2, 344-55 (Jan.16, 1961).
The analytic properties of the non-relativistic deuteron photodisintegration matrix element are studied as a function of angle, for fixed energy. The proton and neutron interact through a static potential, which is a superposition of Yukawa potentials. Spin complications are neglected. The result obtained coincides with the predictions of a Mandelstam representation proposed by de Alfaro and Rosetti starting from the first five terms in the expansion of this matrix element, calculated in a field theory in which the deuteron is treated as an elementary particle coupled to the neutron and proton. The interest in the present work is, firstly, that one of the initial particles is a bound state and, secondly, that in the proposed Mandelstam representation the cuts start at anomalous thresholds of the type studied by Karplus, Sommerfeld and Wichmann. An analogous result, concerning analyticity of amplitudes corresponding to one partial wave given as a function of energy, has already been given by de Alfaro and Rosetti. I.J.R.Aitchison

12130 A NOTE ON THE DEUTERON PHOTODISINTEGRATION.
V.De Alfaro and C.Rossetti.
Nuovo Cimento (Italy), Vol. 20, No. 1, 194-7 (April 1, 1961).
A preliminary check on the validity of extrapolation procedures in reactions involving composite particles is proposed. For the deuteron photodisintegration process, the forward pole is calculated in a non-relativistic "impulse" approximation, and the residue compared with that found from an extrapolation using second-order polynomials. The agreement is claimed to be surprisingly good. The analysis is done for 16 values of the incoming photon lab. energy, in the range 65-455 MeV. For each energy there are between 4 and 6 experimental points, and the error on them is stated to be large. No estimate of the consequent error in the extrapolation is given. I.J.R.Aitchison

12131 ON THE CHARGE EXCHANGE COLLISION IN NUCLEON—DEUTERON. Y.Sakamoto.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 259-76 (Feb., 1961).
The charge-exchange nucleon—deuteron collision is investigated using the two-nucleon scattering phase-shifts, in order to supplement information regarding the two-nucleon interaction with the singlet isotopic spin state, and also to study a beam source of

partially polarized neutrons which is very useful in investigating the interaction between neutrons and certain nuclei. The differential cross-section, polarization and triple scattering parameters of the nucleon ejected in the charge-exchange nucleon–deuteron collision are calculated using the Gammel–Thaler and Signell–Marshak phase-shifts. The energy distribution of the ejected nucleon is calculated by means of the cross-section for magnetic dipole photodisintegration of the deuteron, instead of the explicit use of the wave-functions of the di-neutron (or di-proton) and the deuteron to evaluate the nuclear matrix element. The polarization and triple scattering parameter of the nucleon quasi-elastically ejected from a nucleus, say C^{12}, in the charge-exchange collision and of the nucleon caused by the free n(p,n)p and p(n,p)n processes are calculated for comparison.

Alpha-particles

12132 STOPPING POWER OF C FOR ^{210}Po α-PARTICLES. S.Barkan.
Nuovo Cimento (Italy), Vol. 20, No. 3, 443-9 (May 1, 1961).

The range of Po^{210} α-particles was measured in pure elemental carbon. The carbon foils were prepared by spraying colloidal graphite in isopropyl alcohol on to a glass plate, drying, and then floating on the surface of water. Semiconductor counters were used as detectors. The range was found to be 4.43 mg/cm^2, which corresponds to a value of 0.899 ± 0.009 for the atomic stopping power of carbon relative to air. This agrees well with earlier values obtained from measurements with compounds by use of Bragg's additive law.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

12133 THE ALPHA-PARTICLE COMPONENT OF THE PRIMARY COSMIC RADIATION OVER NORTHERN ENGLAND. G.R.Stevenson and C.J.Waddington.
Phil. Mag. (GB), Vol. 6, 517-30 (April, 1961).

Alpha-particles of the primary cosmic radiation were studied in a stack of nuclear emulsions exposed over Northern England on July 29, 1959. A flux of 167 ± 12 α-particles m^{-2} ster^{-1} sec^{-1} was found. The energy spectrum was examined between the cut-off energy of about 250 MeV per nucleon and an energy of 1.5 BeV per nucleon. It was not found to be significantly different from that observed during solar maximum. The energy spectrum was also examined as a function of zenith angle. An apparently significant linear relationship was established between neutron monitor counts recorded at sea level and primary α-particle flux values. A value of 24.0 ± 2.4 cm was determined for the mean free path of α-particles in nuclear emulsions, which is somewhat higher than previously reported values.

12134 EMISSION OF CARBON GROUP HEAVY NUCLEI FROM A 3$^+$ SOLAR FLARE. H.Yagoda; R.Filz and K.Fukui.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 626-8 (June 1, 1961).

Following an intense flare on 12 November 1960, a 10 × 15 cm block of Ilford G5 nuclear emulsion, flown in the Discoverer XVII satellite, recorded the incidence of an intense beam of cosmic particles of Z = 6 ± 2 emitted by the sun during the life-time of the flare. The particles were identified as heavy nuclei of the C group. D.R.Barber

12135 INTENSITY INCREASE OF DIFFERENT COMPONENTS OF COSMIC RADIATION PRIOR TO THE MAGNETIC STORM OF MAY 11, 1959. B.Trumpy and T.Svanes.
Arbok Univ. Bergen mat.-nat. Ser. (Norway), 1961, Paper 8, 14 pp.

The cosmic-ray storm connected with the magnetic storm of May 11, 1959 was investigated on the basis of recordings from a great number of stations spread over the globe. At several of these stations an increase of the radiation intensity was observed preceding the sudden commencement of the magnetic storm. In this paper are given the results of extensive studies of this increase effect and its dependence on the longitude and latitude of the stations. The additional radiation preceding the commencement of the ma netic storm has a distinct anisotropy in the way that it is found at the daylight face of the earth. The anisotropy of this augmentation-effect is also shown by directional measurements the hard component of cosmic rays at the Norwegian stations Bergen and Tromsø. The results of these measurements suppo the assumption that the increase effect is due to a reflection of cosmic-ray particles from the approaching face of the magnetiz solar stream.

12136 ON THE DENSITY SPECTRUM OF ELECTRON–PHOTON COMPONENT OF EXTENSIVE AIR SHOWE OF COSMIC RADIATION. J.Massalski and L.Turek.
Acta phys. Polon.(Poland), Vol. 19, No. 6, 637-45 (1960).

Measurements of the exponent of the density spectrum for t electron–photon component of the extensive air showers of cosr radiation were made by means of a 48-channel hodoscope conne with 6 counter sets. The results obtained show that, within the limits of experimental error, the exponent does not vary with th thickness of a lead absorbed (in the range 0-27 mm).

12137 ON THE ELECTRONIC COMPONENT OF EXTENSIV AIR SHOWERS NEAR THE AXIS.
T.Kameda, Y.Toyoda and T.Maeda.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1565-74 (Sept., 1960).

Using two multiplate cloud chambers and five density detect consisting of 250 G.M. counter hodoscopes, characters of the electronic component of extensive air showers were investigated fo various distances from the axis in the range $r \leq 10$ m at 2770 m alti The size N of the selected showers extended from 1×10^5 to $2 \times$ The following results were obtained: (1) the integral size spect can be represented by a power law of the form $N^{-\gamma}$, where the value of γ varies from 1.5 to 2.0 as the size increases; (2) the lateral density distribution of the high-energy electronic compo with the energy E ≥ 1 BeV fits well to that of the pure electroni shower with the age parameter s = 1.4; (3) the ratio of the densi of high-energy electrons and photons to that of all electrons is independent of the atmospheric depth; (4) the integral energy spectrum can be expressed by the E^{-n} within the energy region 250 MeV ≤ E ≤ 1 BeV, and the value of n shifts from 0.7 to 1.2 v increasing r; (5) the lateral distribution of the energy flux carri by the electronic component is expressed by the form $r^{-(1.57 \pm 0}$ (6) the showers having steeper lateral distribution of electrons the average one near the axis contain more high-energy rays; (7) the average zenith angle distribution is represented by the fo $\cos^{6.7 \pm 1.4}\theta$, however that of showers containing more high-ene rays by the form $\cos^{10.0 \pm 2.0}\theta$.

12138 THE DIFFERENTIAL ELECTRON DENSITY SPECT RUM OF AIR SHOWERS AT HIGH DENSITIES.
R.J.Reid, K.Gopaulsingh, D.E.Page, M.Idnurm, C.B.A.McCusker J.Malos, D.D.Millar and G.Winterton.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 103-12 (July, 1961).

The density spectrum of cosmic-ray air showers was meas ed using Wilson cloud chambers in two different density regions From 50 to 500 particles per square metre the differential spec rum can be approximated by a power law of exponent −2.5, in gc agreement with many previous results. Above 1100 particles pe square metre the measured exponent is −3.9 ± 0.5. The result compared with recent experiments using emulsion chambers an explanation in terms of the characteristics of high-energy nucle interactions is outlined.

12139 THE SOLAR DIURNAL VARIATION OF COSMIC RA DURING 1958 AND 1959, AT MAKERERE, HERMAN AND HERSTMONCEUX. D.M.Thomson.
Phil. Mag. (GB), Vol. 6, 573-86 (April, 1961).

The results of observations of the solar diurnal variation i cosmic radiation at Makerere (East Africa), Hermanus (South Africa), and Herstmonceux (England) are presented for the year 1958 and 1959. The average amplitude and phase of the 24 hr component of the variation were obtained at each station and the relative values were compared with the values predicted by two types of modulation of the primary spectrum. In the first case modulation of the type $\Delta n(P)/n(P) = a \cdot P^{-1}$ was considered, whe P is the magnetic rigidity of the primary particle. The best ac of the main features of the observations was given if the modula was effective for rigidities in excess of a cut-off value which averaged 15 GV, the value of a being 0.236, and if the direction maximum modulation was 79°, to the east of the sun–earth line In the second case the primary spectrum was considered to be

...lated in the manner suggested on theoretical grounds by ... t (1960). Neither model gives complete agreement with ... rvation.

2140 SECONDARY COSMIC-RAY PHOTONS BELOW CASCADE ENERGY. K.A.Anderson.
...s. Rev. (USA), Vol. 123, No. 4, 1435-9 (Aug. 15, 1961).
Investigations with small unshielded scintillation crystals ...ied through the atmosphere by balloons, show large fluxes of ...ons in the energy region 30 to 300 keV in equilibrium with the ...ary cosmic-ray beam. At 90 g cm^{-2} depth the flux is about ...hotons cm^{-2} sec^{-1} compared with a charged particle flux ...rmined from a Geiger tube of 1.9 cm^{-2} sec^{-1} at this same depth. ...photon flux at zero depth, taken to be the albedo of this ...ondary cosmic-ray component, was estimated by extrapolation ...e 8 photons cm^{-2} sec^{-1} greater than 30 keV.

NUCLEUS

12141 CORE RECONSTITUTION IN HEAVY DEFORMED NUCLEI. R.K.Sheline.
...s. Rev. Letters (USA), Vol. 6, No. 12, 691-4 (June 15, 1961).
Recent experimental evidence on some deviations from smooth ...tematics of vibrational and rotational characteristics in heavy ...ormed nuclei is enumerated. A tentative explanation in form of ...ore reconstitution on the basis of the Nilsson level systematics ...given. Forbidden transitions between nuclei with different ...uctures are predicted. F.Herbut

12142 A COMPLETE ORTHOGONAL EXPANSION FOR THE NUCLEAR THREE-BODY PROBLEM. I. ROTATIONAL ...NCTIONS. R.E.Clapp.
...n.Phys. (USA), Vol. 13, No. 2, 187-236 (May, 1961).
In the nuclear three-body problem, relativistic effects and ...n-central forces mix states of different L and S but the same J. ...l sixteen of the states for $J = \frac{1}{2}$ are exhibited in an eight-compon... ...t vector notation which displays all structural details, and in a ...ore compact spin-operator formulation. In addition, an abbrevi... ...ed notation is introduced through which any state is characterized ...lly and clearly, showing its quartet or doublet character, its ...lue of J and M_J, the particular vector, dyadic, or polyadic used in ...s construction if it is not an S state, and thereby its parity and L ...lue. With this notation many simple operators (spin, derivative, ...rmutation) act directly on the pertinent labels. More complicated ...erators (tensor, spin—orbit) can all be reduced to the simple ...erators and a set of twelve "primary scalar operators". The ...fect of each of the twelve primary operators on each of the sixteen ...otational functions for $J = \frac{1}{2}$ was worked out and is given as a set ...f twelve 16-by-16 matrices which can be combined by matrix ...ultiplication to give the effect of the more complicated secondary ...erators. The procedure to be followed for $J = \frac{3}{2}$ and higher an... ...ular momenta is pointed out. Isospin functions are introduced, ...nd the group-theoretical properties of the combined spin and ...ospin functions are examined.

12143 APPLICATION OF NUCLEON—NUCLEON DISPERSION RELATIONS TO NUCLEAR MANY-BODY PROBLEM.
...Hamamoto and H.Miyazawa.
...hys. Rev. (USA), Vol. 123, No. 5, 1860-4 (Sept. 1, 1961).
A method is given of obtaining the nucleon—nucleon scattering ...mplitude within nuclear matter, when the nucleon—nucleon dis... ...ersion relations are known. This is attained by establishing the ...ispersion relation for the scattering amplitude under the influence ...f the Pauli exclusion principle in intermediate states. With this ...odified amplitude the binding energy of the nucleus is calculated ...sing Brueckner's method. The binding energy per nucleon turns ...ut to be -13.2 MeV, if the contribution of the three-pion exchange ...otential is adjusted to give the correct nuclear density. The im... ...lication of these results is discussed.

12144 THE COMPARISON OF d-SHELL NUCLEI WITH THE NILSSON MODEL. L.L.Green, J.C.Willmott and G.Kaye.
...uclear Phys. (Internat.), Vol. 25, No. 2, 278-81 (May, 1961).
The effects of the isobaric spin and of the μ^2 term in the ...armonic oscillator potential on the energy-level spacings of the ...istorted oscillator potential are discussed.

12145 ON ENERGY MATRICES FOR THE INDEPENDENT PARTICLE MODEL. H.Horie and K.Sasaki.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 475-92 (March, 1961).
A method which makes use of Fourier transforms of two-body interactions for the calculations of energy matrices in the inde... ...pendent particle model is proposed. The non-central interactions as well as central ones can be easily expanded into series of tensor products of spherical harmonics by this procedure. Further... ...more, the radial integrals can be reduced to simple integrals which involve the Fourier transforms of the radial dependence of the interactions. For the harmonic oscillator wave-functions, the procedure can be easily carried out and explicit formulae for the integrals are obtained. Useful tables for the calculations of the integrals for the central, tensor and spin–orbit interactions are given.

12146 A STUDY OF NUCLEAR POTENTIAL ENERGY SURFACES AND GAMMA VIBRATIONS. D.R.Bès.
K. Danske Vidensk. Selsk. mat.-fys. Medd. (Denmark), Vol. 33, No. 2, 39 pp. (1961).
The theory of the collective properties of the nuclear shell model has progressed recently due to the introduction of the simple pairing force to simulate the residual nucleonic interaction. Work... ...ing within the framework of the adiabatic approximation, the present paper studies the consequence of this model for the γ-dependent terms of the nuclear potential energy surface. The simplified case of nucleons in a harmonic oscillator potential is considered first. Then, the energies and transition probabilities are calculated for γ-vibrations of deformed nuclei of axial symmetric shape. In addition, numerical calculations, based on realistic wave functions for nucleons in deformed nuclei, are performed in a few cases and are compared with empirical data.

DIRECT EVIDENCE FOR α-PARTICLE CLUSTERING IN NUCLEI. See Abstr. 12222

12147 NUCLEAR ORIENTATION OF Nd^{147}. G.A.Westenbarger and D.A.Shirley.
Phys. Rev. (USA), Vol. 123, No. 5, 1812-18 (Sept. 1, 1961).
Nd^{147} was aligned and polarized at low temperatures in a neodymium ethylsulphate lattice. A saturation correction for susceptibility was verified. The effect of nondiagonal interactions on nuclear orientation was illustrated. Spin assignments of $\frac{5}{2}^+$, $\frac{3}{2}^+$, $\frac{5}{2}^+$, and $\frac{3}{2}^+$ were made for the excited states of Pm^{147} at 91, 410, 531, and 686 keV, respectively. Mixing ratios were obtained for six mixed γ-rays in Pm^{146}. The magnitude of the amplitude mixing ratio $\delta(E2/M1)$ was found to be approximately proportional to γ-ray energy. Evidence was obtained that the β branches with end points at 0.23, 0.38, and 0.81 MeV are mostly of the L = 0 type.

12148 MAGNETIC MOMENTS OF 69 MIN Ag^{104} AND 27 MIN Ag^{104m}.
O.Ames, A.M.Bernstein, M.H.Brennan and D.R.Hamilton.
Phys. Rev. (USA), Vol. 123, No. 5, 1793-1800 (Sept. 1, 1960).
The hyperfine structure separations of 69 min Ag^{104} and of 27 min Ag^{104m} were measured using the atomic-beam magnetic-resonance method. The results are: $\Delta\nu(I = 5)$ (69 min Ag^{104}) = $33\,500_{-1000}^{+2000}$ Mc/s, $\Delta\nu(I = 2)$ (27 min Ag^{104m}) = 35 000 ± 2000 Mc/s. The sign of the nuclear magnetic dipole moment was found to be positive for both states, and by use of the Fermi—Segrè formula one obtains $\mu_I(I = 5) = +4.0_{-0.1}^{+0.2}$ n.m., $\mu_I(I = 2) = +3.7 \pm 0.2$ n.m. Nuclear configurations which give these moments are discussed and comments are made on the difference between Ag^{104} which shows a 2^+, 5^+ angular momentum recoupling doublet and Ag^{106} and Ag^{110} which show a 1^+, 6^+ doublet.

12149 Rb^{85}—Rb^{86} HYPERFINE-STRUCTURE ANOMALY. N.Braslau, G.O.Brink and J.M.Khan.
Phys. Rev. (USA), Vol. 123, No. 5, 1801-11 (Sept. 1, 1961).
The atomic-beam magnetic-resonance method with separated oscillatory fields was used to measure the hyperfine structure separation and magnetic dipole moment of the isotopes Rb^{85} and 18.6-day Rb^{86} in the $^2S_{1/2}$ electronic ground state. Observation of the separation of a $\Delta F = \pm 1$ doublet in the intermediate field region gives the value of the moment; the minimum value of the mean doublet frequency gives the value of $\Delta\nu$. Observation of another $\Delta F = \pm 1$ doublet in low field also yields a value for $\Delta\nu$. Results obtained for Rb^{85} are in good agreement with previously published values and indicate that transition frequencies calculated from the Breit—Rabi equation agree with experiment to at least one part per million. For Rb^{86} the following values are obtained for the $^2S_{1/2}$

ground state: $\Delta\nu = 3946.883(2)$ Mc/s, $g_I = -4.590(4) \times 10^{-4}$, and $\mu_I = -1.6856(14)$ n.m. (without diamagnetic correction). The hyperfine-structure anomaly arises in part from the difference of the volume distribution of nuclear magnetism in the two nuclei and is defined as the deviation from equality of the ratio of the hyperfine-splitting factors of two isotopes to the ratio of their nuclear g factors. For these two isotopes its value is found to be $^{85}\Delta^{86} = 0.17(9)\%$. The Bohr–Weisskopf theory of the h.f.s. anomaly is applied to these isotopes with calculations based on a single-particle model with varying distributions of spin and orbital contributions to the magnetic moment.

EFFECTS OF DISTRIBUTED NUCLEAR MAGNETIZATION ON HYPERFINE STRUCTURE IN ODD-A NUCLEI. See Abstr. 12152

QUADRUPOLE MOMENT OF Cr^{53}. See Abstr. 11490

12150 QUADRUPOLE MOMENT OF Li^7 AND QUADRUPOLE COUPLING CONSTANT OF Li_2.

S.L.Kahalas and R.K.Nesbet.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 549-50 (May 15, 1961).

Electric field gradients in Li^7 and Li_2 were calculated. These were used in conjunction with a recent high-precision measurement of the quadrupole coupling constant of Li^7 in LiH to evaluate $Q(Li^7)$ and the quadrupole coupling constant of Li_2. R.A.Ballinger

Energy Levels

12151 SPIN ORDER IN THE DOUBLET AT THE SECOND EXCITED LEVEL IN EVEN–EVEN MEDIUM NUCLEI.

M.Sakai.
J. Phys. Soc. Japan, Vol. 15, No. 5, 933 (May, 1960).

It is pointed out that the second excited state of medium nuclei often appears to be a close 2^+, 4^+ doublet. The energy systematics of this doublet in medium nuclei is discussed. L.L.Green

12152 CONFIGURATION MIXING AND THE EFFECTS OF DISTRIBUTED NUCLEAR MAGNETIZATION ON HYPERFINE STRUCTURE IN ODD-A NUCLEI.

H.H.Stroke, R.J.Blin-Stoyle and V.Jaccarino.
Phys. Rev. (USA), Vol. 123, No. 4, 1326-48 (Aug. 15, 1961).

The theory of Blin-Stoyle and of Arima and Horie, in which the deviations of the nuclear magnetic moments from the single-particle model Schmidt limits are ascribed to configuration mixing, is used as a model to account quantitatively for the effects of the distribution of nuclear magnetization on hyperfine structure (Bohr–Weisskopf effect). A diffuse nuclear charge distribution, as approximated by the trapezoidal Hofstadter model, is used to calculate the required radial electron wave-functions. A table of single-particle matrix elements of R^2 and R^4 in a Saxon–Woods type of potential well is included. Explicit formulae are derived to permit comparison with experiment. For all of the available data satisfactory agreement is found. The possibility of using hyperfine structure measurements sensitive to the distribution of nuclear magnetization in a semiphenomenological treatment in order to obtain information on nuclear configurations is indicated.

ENERGY LEVELS OF C^{13}. See Abstr.

C^{11} AND C^{12} NUCLEAR ENERGY LEVELS. See Abstr.

12153 LEVEL SCHEME OF Au^{198} DETERMINED BY ANALYSIS OF HIGH-PRECISION CAPTURE GAMMA-RAY MEASUREMENTS. B.Hamermesh, J.E.Monahan and R.K.Smither.
Ann. Phys. (USA), Vol. 13, No. 2, 284-306 (May, 1961).

The gamma-ray spectrum resulting from the capture of thermal neutrons by Au^{197} has been investigated by use of the Argonne 7.7 m bent -crystal spectrometer. A total of 122 lines corresponding to transition energies less than 835 keV were observed. Their energies were determined with an average precision of 1 part in 5000. The method of generating a "most probable" level scheme for Au^{198} from these measurements is described. A scheme containing 25 states is obtained which shows an unusual "fine structure" grouping of several levels.

12154 NUCLEAR ENERGY LEVELS OF N^{16}.

M.G.Silbert, N.Jarmie and D.B.Smith.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 438-42 (June, 1961).

Thirteen energy levels of N^{16} were determined in the range of excitation from 0 to 5.6 MeV by a high-resolution study of the proton spectrum from the $N^{14}(t,p)N^{16}$ reaction. Levels above the well-known ground state quartet are found to 3.340, 3.506, 3.956, 4.31 4.392, 4.773, 5.059, 5.141, 5.230 and 5.526 MeV. These energies have been assigned standard deviations of from 10 to 25 keV. L widths and reaction cross-sections are also reported. The resu of this experiment are compared with previous experiments.

12155 GAMMA-RAYS FROM THE 7.56 MeV LEVEL IN O^{15}.

T.Tabata and K.Okano.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1552-5 (Sept., 1960).

The gamma-rays from the $N^{14}(p,\gamma)O^{15}$ reaction at the $E_p = 278$ keV resonance, corresponding to the 7.56 MeV level in O^{15}, were studied with a large crystal scintillation spectrometer The direct ground state transition gamma-ray of about 3% in inte of the total decay was found to exist in addition to the three know cascase lines. Angular distributions of these gamma-rays are a isotropic, supporting the $J^\pi = \frac{1}{2}+$ assignment to the resonance s The transition strength (radiation width in units of Weisskopf sin particle width) of the direct ground state transition E1 gamma-r is calculated to be $|M|^2 = 4.15 \times 10^{-6}$, which is by a factor of 10 smaller than the normal E1 transition strength found in light nuclei. Other transitions in O^{15} are estimated to be of normal strength compared with Wilkinson's estimation. [Proceedings o the Rehovoth Conference on Nuclear Structure – Amsterdam: North-Holland Publishing Co. (1958) p. 175].

12156 THE GYROMAGNETIC RATIO OF THE 155 keV ROTATIONAL LEVEL IN Os^{188}.

A.Karlsson, C.A.Lerjefors and E.Matthias.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 385-403 (June, 1961).

Using a four-channel coincidence apparatus the authors inv gated the influence of an external magnetic field on the angular correlation of the 931–155 keV cascade in Os^{188}. The strength the magnetic interaction was found to be $|\omega_L\tau_N| = 0.0423 \pm 0.0$ rad for a magnetic field of ±29200 G. Averaging the results of lifetime determinations it was found that $T_{\frac{1}{2}} = (5.8 \pm 0.5)10^{-10}$ s, which gives $g_R = +0.36 \pm 0.04$ for the gyromagnetic ratio of the 155 keV rotational state. This result was derived under the ass tion that no other perturbations were present in the liquid sourc used. This assumtpion is supported by the authors' measureme was well as earlier determinations of the angular correlation coefficients of the 0–2–0-cascade. The result is in agreement with recent calculations based on the superconductor theory of t nucleus. See also following abstract.

12157 THE GYROMAGNETIC RATIO OF THE 137 keV ROTATIONAL LEVEL IN Os^{186}.

C.A.Lerjefors, E.Matthias and E.Karlsson.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 404-8 (June, 1961).

Using a four-channel coincidence apparatus the authors inv gated the influence of an external magnetic field on the angular correlation of the 631–137 keV cascade in Os^{186}. The strength the magnetic interaction was found to be $|\omega_L\tau_N| = 0.043 \pm 0.01$ rad for a magnetic field of ±29 200 G. Averaging the result of al lifetime determinations, it is found that $T_{\frac{1}{2}} = (7.0 \pm 0.9) \times 10^{-10}$ s This gives $g_R = +0.30 \pm 0.08$ for the gyromagnetic ratio of the 137 keV rotational state. There is no evidence for the existence internal perturbations in the liquid source used.

12158 THE REACTION $^{28}Si(p,\gamma)^{29}P$.

K.J.van Oostrum, N.Hazewindus, A.H.Wapstra, J.W.Olness and J.L.Parker.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 409-20 (June, 1961).

The level structure of P^{29} was investigated using the reacti $Si^{28}(p,\gamma)P^{29}$ for proton energies between 0.3 MeV and 2.3 MeV. Levels of P^{29} at 3.09 MeV, 4.34 MeV and 4.76 MeV were excited with (p,γ) resonances at proton energies of 0.371 MeV, 1.65 Me and 2.09 MeV, respectively. The strength γ of a resonance expe for excitation of a 3.49 MeV level in P^{29} was derived to be less 5×10^{-4} eV. This low value is attributed to K-forbiddenness of gamma-ray decay of this level. Gamma-rays from the 0.371 M resonance lead to levels at 1.95 MeV and 1.37 MeV; those from 1.65 MeV resonance lead to the ground state and, rather weakly, the 1.37 MeV state; gamma-rays from the 2.09 MeV resonance to the ground state only. Angular distributions are in agreemen with the following spin assignments for the levels of P^{29}: 1.37 M ($\frac{3}{2}$), 1.95 MeV ($\frac{1}{2}$), 3.09 MeV ($\frac{5}{2}$), 4.34 MeV ($\frac{3}{2}$) and 4.76 MeV ($\frac{5}{2}$). T excited states found in these experiments are assigned to rotati bands based on Nilsson orbits 8, 9, 10, 11 and 16.

159 LOWER EXCITED STATES IN P^{29} FROM THE $Si^{28}(p,\gamma)P^{29}$ REACTION. K.Okano, T.Tabata, K.Fukuda and J.Muto.
ys. Soc. Japan, Vol. 15, No. 9, 1556-64 (Sept., 1960).
The gamma-rays from the $Si^{28}(p,\gamma)P^{29}$ reaction at the 369 keV resonance were studied with a large NaI(Tl) crystal illation spectrometer. The resonance state, corresponding to ..116 ± 0.012 MeV fourth excited state in P^{29}, was found to decay 4 ± 4)% to the first excited state at 1.384 ± 0.008 MeV and by 4)% to the second excited state at 1.961 ± 0.013 MeV which yed predominantly to the ground state. From the angular ribution measurements of each gamma-ray line, spins and ties of these lower levels in P^{29} were unambiguously assigned ollows: 1.38 MeV(1st), J = 3/2+; 1.96 MeV(2nd), J = 5/2+; MeV(4th), J = 5/2+. These assignments are all consistent with known character of the corresponding levels in the mirror eus Si^{29}, and are also in agreement with the theoretical dictions. From the precise gamma-ray energy measurements; Q-value of this reaction was estimated as 2.760 ± 0.013 MeV, ch is by about 36 keV larger than the published value based on β-ray end-point energy measurement. The resonance strength + 1)$\Gamma_p\Gamma_\gamma/(\Gamma_p+\Gamma_\gamma)$ was found to be (4.7 ± 0.8) × 10^{-3} eV.

.2160 NUCLEAR LEVELS IN A NUMBER OF EVEN–EVEN RARE EARTHS (150 ≤ A ≤ 184).
armatz, T.H.Handley and J.W.Mihelich.
's. Rev. (USA), Vol. 123, No. 5, 1758-86 (Sept. 1, 1961).
To obtain more data on the system of levels in even–even lei, a number of such nuclei (150 ≤ A ≤ 184) were studied with ctron-capturing sources in permanent magnet spectrographs ie measurements were made with scintillation counters. Data firming recently reported results on the decay of Tb^{152}, Tb^{156}, Ho^{162} were obtained. It was found that Eu^{150} has two isomeric tes $T_{1/2}$ =(14 hr and > 5 yr). Levels at 740.7 (0+) and 773.3 (4+) in Sm^{150} are proposed. A study of the two isomeric activities Tb^{154} indicated the existence of levels in Gd^{154} which may be scribed as a gamma-vibrational band (at 997.3 keV) and a beta-rational band (at 680.6 keV). The new data for Tm^{166} (7.7 hr) consistent with levels in Er^{166} at 2137.3 and 2164.6 keV, both which are probably 3 states and which exhibit considerably ferent branching ratios of the de-exciting transitions. The decay Lu^{172} appears to populate a large number of even-parity levels Yb^{172} which may be arranged in rotational bands corresponding to mary or base states at 1174.0 keV (I = 3+), 1467.5 keV (I = 2+), 34.3 keV (I = 3+), 1702.1 keV (I = 3+), 2075.0 keV (I = 4+), and 87.3 keV (I = 4+). The very complex decay of the two isomers of ^{182} excite many odd-parity levels whcih may be arranged in seven more bands. In addition, even-parity beta- and gamma-vibra-nal bands may be populated. Electron-capture decay of Re^{186} pulates a gamma-vibrational band in W^{186} of spins 2, 3, and 4. ta relevant to the rotational energy parameters and ratios of mma-ray transition propabilities from the various states are esented. As a corollary, data on the decay of Eu^{149} are presented nce this activity was present in some of the composite sources.

NUCLEAR DECAY RADIOACTIVITY

12161 MEAN LIFE OF THE 1.61-MeV LEVEL OF Mg^{25}.
V.K.Rasmussen, F.R.Metzger and C.P.Swann.
ys. Rev. (USA), Vol. 123, No. 4, 1386-92 (Aug. 15, 1961).
Nuclear resonance fluorescence techniques were used to easure the mean life of the 1.61 MeV level of Mg^{25} and the 1.83 MeV vel of Mg^{26}. The exciting γ-radiation was obtained by bombarding etallic Mg^{25} and Mg^{26} targets with 4.0 and 4.4 MeV protons. For e Mg^{25} level, assumed to be $\frac{7}{2}^+$, the self-absorption of the resonance diation gives $\tau = (2.5^{+0.8}_{-0.4}) \times 10^{-14}$ sec. The angular distribu-n for the resonance scattering was found to be

$$1 + (0.42 \pm 0.03)P_2(\cos\theta) + (0.03 \pm 0.003)P_4(\cos\theta),$$

ere the errors given are statistical only. For other reasons it believed that the correct coefficient of the P_4 term is approxi-ately zero. For the Mg^{26} level, the apparent resonance scattering oss-section combined with some previous estimates of slowing-wn times for the excited nuclei gives $\tau = (7 \pm 3) \times 10^{-18}$ sec. Further evidence as to the collective nature of these nuclei and of Al^{27} is discussed. Support is given to the suggestion of the Chalk River group that the 1.61 MeV Mg^{25} and the 2.21 MeV Al^{27} levels are the $\frac{1}{2}^+$ second members of $K = \frac{5}{2}^+$ rotational bands based on the ground states. For the Mg^{25} level, spin and parity $\frac{1}{2}^+$ is required to obtain agreement between the quadrupole transition probability from these measurements and that found by Coulomb excitation.

12162 THE HALF-LIFE OF RUBIDIUM-87.
A.McNair and H.W.Wilson.
Phil. Mag. (GB), Vol. 6, 563-72 (April, 1961).
A 4π proportional counter system capable of examining thin sources of extended area was used to determine the half-life of Rb^{87}, which was found to be (5.25 ± 0.10) × 10^{10} years. Corrections for absorption of electrons and for scattering in the source and in the source supporting foil are discussed.

12163 HALF-LIVES OF SOME NUCLEAR STATES IN THE MILLIMICROSECOND REGION. T.D.Nainan.
Phys. Rev. (USA), Vol. 123, No. 5, 1751-7 (Sept. 1, 1961).
A time-to-pulse height converter, fast coincidence arrangement, and multichannel analyser were used to measure half-lives of some nuclear states in the millimicrosecond range. The half-lives of the following nuclear states were measured: the 325 keV level in V^{51}, (2.80 ± 0.04) × 10^{-10} sec; the 555 keV level in Mn^{53}, (1.85 ± 0.07) × 10^{-9} sec; the 1490 keV level in Co^{57}, (1.00 ± 0.05) × 10^{-9} sec; the 245 keV level in Se^{77}, (1.30 ± 0.08) × 10^{-9} sec; the 155 keV level in Sb^{119}, (0.83 ± 0.2) × 10^{-9} sec; the 123 keV level in Cs^{131}, (4.15 ± 0.08) × 10^{-9} sec; and the 103 keV level in Eu^{153}, (3.8 ± 0.02) × 10^{-9} sec. The well-known level of Ta^{181} at 48 keV gives (1.10 ± 0.02) × 10^{-8} sec and that of Gd^{154} at 122 keV, 1.15 × 10^{-9} sec. A comparison with the results given by theory is made.

12164 ABSOLUTE DETERMINATION OF THE ENERGY OF IMPORTANT NATURALLY-OCCURRING ALPHA-PARTICLES. A.Rytz.
Helv. phys. Acta (Switzerland), Vol. 34, No. 3, 240-64 (1961).
In German.
Reports new and more precise measurements of the energies of alpha-rays emitted by Po^{210}, Po^{212}, Po^{214}, Bi^{212}, Bi^{211}, Ra^{223}, Rn^{219} and Po^{215}. A 180° permanent magnet spectrometer was used in the measurements. R.H.Thomas

12165 BRANCHING RATIO OF α AND β EMISSIONS FROM ^{212}Bi (ThC). S.Barkan.
Nuovo Cimento (Italy), Vol. 20, No. 3, 450-3 (May 1, 1961).
Semiconductor counters, which have good efficiency and energy resolution were used to measure the branching ratio with increased precision. The measurement was made as usual by comparison of the intensity of the low-energy (< 7 MeV) alphas coming directly from the Bi^{212} with that of the high-energy (> 7 MeV) alphas coming from the Po^{212} that is produced by the β-decay of the Bi^{212}. The average of 8 runs gave $\alpha/(\alpha + \beta)$ = 0.358 ± 0.001.

12166 PARITY CONSERVATION IN NUCLEAR REACTIONS: SEARCH FOR α DECAY OF THE 8.88 MeV STATE IN O^{16}. R.E.Segel, J.W.Olness and E.L.Sprenkel.
Phys. Rev. (USA), Vol. 123, No. 4, 1382-5 (Aug. 15, 1961).
A search was carried out for the parity-nonconserving α-decay of the 8.88 MeV (2^-) state in O^{16} by examining the alpha-particle spectrum following N^{16} β-decay. An upper limit of $(\Gamma\alpha/\Gamma\gamma) < 2 \times 10^{-6}$ was determined which is shown to lead to the estimate that $\gamma^2 \sim < 2 \times 10^{-12}$. The alpha-particle group corresponding to disintegration of the broad 9.58 MeV (1^-) state was observed and the log ft for the β-decay to this state found to be 6.8 ± 0,1, the slow transition rate being in accord with a shell-model prediction that the 9.58 MeV state is due to a three-nucleon excitation. The shape of the alpha-spectrum was fitted with a Breit–Wigner analysis.

12167 INTERMEDIARY EFFECTS IN NUCLEAR BETA DECAY. J.D.Childress.
Phys. Rev. (USA), Vol. 123, No. 5, 1729-34 (Sept. 1, 1961).
Two intermediate meson theories, the vector meson theory and the scalar meson theory, of weak interactions are analysed for non-local effects in nuclear beta-decay processes. The principle effects are (1) the introduction of a nonlinearity in the Kurie plot in both meson theories and (2) the alteration of the electron–neutrino angular correlation in the vector meson theory only. These effects are shown to be quite small, of the order of 0.1% in the most favourable cases, for the lower mass limits imposed on the mesons by the

requirement of compatibility with present experimental data. The magnitude of these effects is considered to be on the threshold, at least, of measurability. Both meson theories produce effective nuclear beta-decay coupling constants that differ in the order of 1% from the effective constants in muon decay.

12168 NEW ISOTOPE, Al^{30}.
E.L.Robinson and O.E.Johnson.
Phys. Rev. (USA), Vol. 123, No. 4, 1349-54 (Aug. 15, 1961).

Scintillation measurements were made of the beta- and gamma-radiation from high-purity natural silicon targets after bombardment with fast neutrons produced by the $Li^7(d,n)Be^8$ reaction ($E_n \lesssim 24$ MeV). In addition to well-known radiations, a beta-spectrum with an end point of 5.05 ± 0.25 MeV and two gamma-rays with energies of 2.26 ± 0.03 and 3.52 ± 0.03 MeV were observed. These gamma-rays and the beta-group decayed, within experimental error, with the same half-life, 3.27 ± 0.20 sec. The assignment of this activity to Al^{30} and the proposed decay scheme are supported by considerations involving the decay schemes of the well-known isotopes produced, half-life studies using portions of both the beta- and gamma-spectra, the features of experimental beta- and gamma-spectra, and nuclear systematics. Strong beta-transitions to the first and second excited states of Si^{30} are inferred from the experimental gamma-spectrum and nuclear systematics. A weak beta-transition (< 2%) to the ground state cannot be excluded by this investigation. Possible spin and parity assignments for the ground state of Al^{30} are 1+, 2+, and 3+. A weak argument is made against a spin 1 assignment. The results of this investigation cannot be used to reduce the ambiguity of the spin assignment further. The resulting Al^{30}—Si^{30} mass difference is 7.29 ± 0.25 MeV.

12169 NEW HAFNIUM ISOTOPE, Hf^{182}.
J.Wing, B.A.Swartz and J.R.Huizenga.
Phys. Rev. (USA), Vol. 123, No. 4, 1354-5 (Aug. 15, 1961).

A new nuclide of hafnium, Hf^{182}, was produced by double neutron capture in Hf^{180} in the intense neutron flux of the materials testing reactor (MTR). Mass-spectrometric analysis of the irradiated hafnium gave a Hf^{182}/Hf^{180} atom ratio of 0.00147 ± 0.00001. The new isotope decays with a half-life of $(9 \pm 2) \times 10^6$ years by β^- emission predominantly to a 271 keV level in Ta^{182}. The number of 271 keV gamma-rays per β^- disintegration is 0.84 ± 0.10. The log ft for the beta-transition to the Ta^{182} ground state is > 15 indicating that this transition is at least third forbidden. The neutron capture cross-section of Hf^{181} is 40^{+40}_{-20} barns.

12170 DECAY OF POTASSIUM 44.
K.Sugiyama, T.Tōhei, M.Sugawara, T.Dazai and Y.Kanda.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1909-12 (Nov., 1960).

An investigation of the decay scheme of K^{44} was made with anthracene- and 5" × 5" NaI(Tl)-scintillation counters, and coincidence techniques. In addition to the 4.91, 3.55 and 2.63 MeV beta-rays, the following gamma-rays were assigned to Ca^{44}: 0.48, 0.63, 0.74, 0.90, 1.06, 1.16, 1.5, 1.74, 2.08, 2.17, 3.4, 4.4, 4.6 and 5.0 MeV. A decay scheme is proposed.

12171 ACTIVITIES OBSERVED IN IRIDIUM AFTER NEUTRON BOMBARDMENT. REMARKS ON A PAPER BY H.H.HENNIES AND A.FLAMMERSFELD.
G.Scharff-Goldhaber and M.McKeown.
Naturwissenschaften (Germany), Vol. 48, No. 4, 96-7 (1961).

Hennies and Flammersfeld (Abstr. 7510, 13169 of 1960) reported a 47 sec activity resulting from the irradiation of iridium with slowed-down neutrons from the reaction $Be^9(d,n)B^{10}$ using 1 MeV deuterons. The observed activity consisted of β-rays with $E_\beta(max) = 2.3 \pm 0.2$ MeV and three γ-rays of 130 ± 4, 323 ± 7, and 625 ± 20 keV, the last two being in coincidence with the β-rays. The activity was ascribed to Ir^{190m} formed by neutron capture in Ir^{189}. They suggested that the β-rays observed might be identical with those previously attributed to Ir^{192m} (1.42 min). The present authors describe new experiments which seem to rule out the above assignment and suggest that the 47 sec 2.3 MeV β-spectrum was due to a rhodium impurity in the iridium. R.E.Meads

12172 ON THE 47 SEC NUCLEAR ISOMER OF IRIDIUM.
H.H.Hennies and A.Flammersfeld.
Naturwissenschaften (Germany), Vol. 48, No. 4, 97 (1961).
In German.

Remarks on several observations made by Scharff-Goldhaber and McKeown on an earlier paper by the authors. (see preceding abstract). S.J.St-Lorant

12173 BETA-DECAY MATRIX ELEMENTS IN Sb^{122}.
G.E.Bradley, F.M.Pipkin and R.E.Simpson.
Phys. Rev. (USA), Vol. 123, No. 5, 1824-34 (Sept. 1, 1961).

Dynamic nuclear orientation was used to study the $2^- \rightleftharpoons 2^+$ 1.42 MeV beta-ray in the decay of Sb^{122}. The Sb^{122}, which was substitutional donor atom in a silicon crystal, was oriented by saturating each of the four $\Delta(m_I + m_J) = 0$ forbidden transitions. The angular distribution of the gamma-ray following the beta- was measured with two scintillation counters. The nuclear an electron relaxation times were determined by the rate of grow and decay of the nuclear orientation. The electron ($\Delta m_J = \pm 1$ $\Delta m_I = 0$) relaxation time was found to be (4.9 ± 1.2) min. The nuclear relaxation can be represented as due to a combination the modulation of the isotropic hyperfine interaction and nucle quadrupole relaxation. For the dipole mechanism, 50 min ≤ T_D ≤ 100 min and for the quadrupole mechanism, 150 min ≤ T_N ≤ 17 min. An analogue computer was used to correct the initial orientation parameters for the effects of nuclear relaxation. I these, data restrictions can be placed upon the relative amoun of angular momentum carried off by the 1.42 MeV β-ray. The modified B_{ij} approximation was then used to analyse this resu conjunction with the beta—gamma angular correlation. There three sets of matrix elements which can explain the observed One set implies that all the antimony atoms are in the simple sites; the other two sets imply that only 40% of the antimony a are in the donor sites. The first set gives V = −0.5 ± 0.1, Y = −0.5 ± 0.1; the second set, V = −4.2 ± 2.0, Y = −1.4 ± 0.5; th third set, V = −6.3 ± 1.0, Y = +1.8 ± 1.5.

12174 SEARCH FOR WEAK GAMMA-RAYS IN THE POSI DECAY OF Mn^{51}.
M.Nozawa, H.Yamamoto, Y.Yoshizawa and Y.Koh.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2137-9 (Dec., 1960).

Weak γ-rays following the decay of Mn^{51} were investigate NaI(Tl) scintillation spectrometer. To eliminate the effect of strong annihilation γ-ray, a new method was used. γ-rays of and 1.17 MeV were found and these intensities were 0.4 ± 0.2 0.2 ± 0.1% of the positron intensity, respectively. The half-li Mn^{51} was determined as 44 ± 1 min.

12175 BETA- AND GAMMA-RAY SPECTROSCOPY OF M AND Mn^{52m}.
T.Katoh, M.Nozawa, Y.Yoshizawa and Y.Koh.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2140-53 (Dec., 1960).

Excited levels of Cr^{52} were studied by investigating the d of Mn^{52}(5.7 days) and Mn^{52m}(21 min), produced by $Cr^{53}(d, 2n)Mn$ By means of a two-directional focusing beta-ray spectrometer NaI(Tl) scintillation spectrometers and a 20-channel pulse hei analyser, following results were obtained: (1) Energies of the main γ-rays from Mn^{52} are 746.8 ± 0.2, 938.1 ± 0.4 and 1434.7 ± 0.8 keV. (2) The maximum energies of the positrons Mn^{52} and Mn^{52m} are 0.572 ± 0.006 and 2.61 ± 0.03 MeV, respec (3) The spins and parities of the levels of 3120, 2373 and 1435 were determined to be 6+, 4+ and 2+, from measurements of c version electrons and angular correlations. (4) Several weak gamma-rays were found, which could be inferred to belong to decays. (5) The half-life of Mn^{52m} is 21 ± 1 min. Its branchin ratio IT/(β^+ + EC) was determined as 2 ± 1%. (6) The energy isomeric transition is 0.383 ± 0.003 MeV, which was decided from K/L + M and the transition probability.

12176 INTERNAL BREMSSTRAHLUNG IN $0^- \rightarrow 0^+$ BETA-TRANSITIONS. F.Janouch.
Nuclear Phys. (Internat.), Vol. 25, No. 2, 328-32 (May, 1961).

Internal bremsstrahlung accompanying a $0^- \rightarrow 0^+$ β-transi is considered. It is shown that experimental investigations of energy dependence of the degree of circular polarization of the internal bremsstrahlung quanta would allow the determination the possible role of pseudo-scalar interaction in nuclear β-dec

12177 TEST OF THE ξ-APPROXIMATION IN SOME FIRS FORBIDDEN $2^- \rightarrow 2^+$ β TRANSITIONS. R.M.Steffen
Phys. Rev. (USA), Vol. 123, No. 5, 1787-93 (Sept. 1, 1961).

The β—γ directional correlations of the first-forbidden no unique $2^- \rightarrow 2^+$ β-transitions of K^{42}, Sb^{122}, and Au^{198} were invest and compared with the predictions of the ξ approximation, wh range of applicability is discussed. Upper limits for the contr bution of the tensor-type matrix element $\int B_{ij}$ to the β transiti were estimated on the basis of the modified B_{ij} approximation anisotropy coefficient $A_2(W)$ in the β—γ directional correlation

...ving the 1.98 MeV β-transition of K^{42} varies from $A_2(1.66) =$ ...)9 ± 0.002 to $A_2(4.60) = -0.049 \pm 0.002$, where W is in units of ... The energy dependence of $A_2(W)$ deviates from the predictions ... ξ approximation by about 40% over the measured energy ... A rough estimate of the upper limit for the contribution ... the B_{ij} component is: $|C_A \int B_{ij}| < 0.3(|V_0| + |Y_1|)$ (in the ...ion of Kotani). The anisotropy factor $A_2(W)$ of the β–γ direct- ... correlation involving the 1.40 MeV β-transition of Sb^{122} varies ... $A_2(1.96) = +0.035 \pm 0.003$ to $A_2(3.5) = +0.081 \pm 0.004$. The ...gy dependence of $A_2(W)$ is well represented by the factor ...W) $(W^2-1)/W$ as predicted by the ξ approximation. The upper ... of the $\int B_{ij}$ contribution to this β transition is estimated as: ... $\int B_{ij} | < 0.15 |Y_1|$ or $|C_A \int B_{ij}| < 0.2 |V_0|$. The anisotropy ...r $A_2(W)$ of the Au^{198} β–γ directional correlation involving the ... MeV β-transition varies between $A_2(1.39) = +0.0076 \pm 0.0010$ ... $A_2(2.78) = +0.0286 \pm 0.0010$, and its energy dependence agrees ... well with the predictions of the ξ approximation. The upper ...t for the $\int B_{ij}$ matrix element is estimated as: $|C_A \int B_{ij}|$ ... $|Y_1|$.

12178 PROBABILITIES OF γ (M_2) TRANSITION IN CERTAIN HEAVY NUCLEI. R.Foucher.

...hys. Radium (France), Vol. 21, No. 10, 751 (Oct., 1960).

...rench.

The probabilities of quadrupolar magnetic γ-transitions (M_2) in ... heavy nucleii Np^{237}, Pa^{231}, Ac^{227}, Ra^{223} are discussed. It is shown ... these transitions are probably in competition with the dipolar ...tric γ-transitions (E_1), which probabilities are found to be lower ... those predicted by models of the independent particle. The re- ...s are tabulated and discussed. It is concluded that the prob- ...ities for M_2 experimental transitions are much lower than those ...dicted by the independent particle model, as was already ob- ...ved earlier in the case of K^{41}, Rb^{85} and Ge^{73}. These M_2 transitions ...m to follow the same rule as the M_1 and M_4 transitions, indicating ...t the magnetic γ-transitions are normally slower that the pre- ...tion of the simplified theory of Weisskopf. L.Mordecai

12179 GAMMA RADIATION FOLLOWING THE DECAY OF Dy^{165}.

Hashizume, T.Takahashi, Y.Tendo and Y.Enomoto.

Phys. Soc. Japan, Vol. 15, No. 12, 2175-8 (Dec., 1960).

The transition of γ-rays in Ho^{165} emitted in the decay of Dy^{165} ...40 min) was studied with γ–γ coincidence and sum coincidence ...chniques. In addition to previously reported γ-rays, (178), ~483, ...d ~515 keV γ-rays were found in coincidence experiments. About ... MeV γ-rays are resolved into 998 and 1055 keV γ-rays. A ...roposed decay scheme is presented. The measured half-life of ...^{165} is 142.4 ± 0.5 min.

12180 THE HALF-LIFE OF VANADIUM-50. A.McNair.

...uil. Mag. (GB), Vol. 6, 559-61 (April, 1961).

The half-life of the naturally occurring odd–odd isotope V^{50} for ...ectron capture decay to the first excited state of Ti^{50} is shown to ...xceed 8×10^{15} years and for negatron decay to the first excited ...ate of Cr^{50} to exceed 1.2×10^{16} years.

12181 SHORT-LIVED ACTIVITY OF Ag^{106}. M.Sakai, H.Ikegami and T.Yamazaki.

Phys. Soc. Japan, Vol. 16, No. 2, 148-52 (Feb., 1961).

24-min Ag^{106} was produced by (n, 2n) reaction. New γ-rays of ...5, 450, 625, 883, 1045, 1190, 1398, 1525, 1730, 1880 and 2170 keV ...re observed with scintillation γ-ray spectrometer. These γ-rays ...re compared with those appearing in the decay of Rh^{106}, Rh^{106m} ...d Ag^{106m}. The β-transition to the second excited level was ...scussed in light of the new β-decay selection rule.

12182 PRECISION MEASUREMENT OF GAMMA RAYS FROM β-DECAY IN Au^{198} AND Au^{199}.

...Hamermesh and R.K.Smither.

...n. Phys. (USA), Vol. 13, No. 2, 307 (May, 1961).

Some gamma-rays which follow β-decay in Au^{198} and Au^{199} were ...easured with high precision.

γ-RAY SPECTRUM OF Au^{198}. See Abstr. 12153

12183 SPECTROSCOPY OF GAMMA RADIATION FROM Nd^{144}, Sr^{88}, AND Pb^{207}.

...E.Monahan, S.Raboy and C.C.Trail.

...hys. Rev. (USA), Vol. 123, No. 4, 1373-81 (Aug. 15, 1961).

The energies of the cascade gamma-rays in Nd^{144} are found to be 1487.0 ± 1.1 keV and 696.7 ± 0.6 keV and the measured energy of the crossover transition is 2186.0 ± 2.2 keV. The agreement of these results is used to justify the claim of 0.1% accuracy for the scintillation spectrometer with anticoincidence annulus for the measurement of gamma-ray energies in the interval from 0.5 MeV to roughly 3.0 MeV. An energy of 570.8 ± 0.5 keV is obtained for the low-energy radiation from Pb^{207} and energies of 1836.2 ± 1.7 keV and 898.7 ± 0.8 keV are reported for two Sr^{88} gamma rays. Also measurements are given for the relative intensities of the 2.18 MeV, 1.48 MeV, and 0.696 MeV gamma rays of Nd^{144}, the relative intensities of the 1.8 MeV and 0.898 MeV transitions in Sr^{88}, and the relative intensities of the 1.06 MeV and 0.57 MeV transitions in Pb^{207}.

12184 EVIDENCE FOR AN ISOMERIC STATE OF Y^{90}. W.L.Alford, D.R.Koehler and C.E.Mandeville.

Phys. Rev. (USA), Vol. 123, No. 4, 1365-8 (Aug. 15, 1961).

The recently reported activity induced by neutron bombardment of niobium was produced by 14 MeV neutrons and by neutrons of energy less than 6 MeV, on both niobium and zirconium. In each case, chemical separation showed the activity to be due to an isotope of yttrium. Two coincident gamma-rays having energies of 0.2000 and 0.485 MeV and a half-life of 3.1 ± 0.1 hr were observed; these observations were in agreement with earlier results. The activity appears very similar to that which has been previously attributed to the decay of Y^{88}. However, threshold considerations and the failure to observe by means of a thin-window Geiger counter any beta emission associated with this gamma activity, point to an isomeric state of Y^{90}. Experiments with separated isotopes of Zr^{90} and Zr^{92} support this assignment.

12185 3.1 HOUR Y^{90m}. W.S.Lyon, J.S.Eldridge and L.C.Bate.

Phys. Rev. (USA), Vol. 123, No. 5, 1747-9 (Sept. 1, 1961).

A 3.1 hr isomer, Y^{90m}, was produced by neutron capture in yttrium. The isomeric transition consists of two coincident gamma rays of nearly equal intensity and energies, 203 and 480 keV. Mass and atomic number assignment was made by cross-bombardment and chemical separations. Modes of production were $Y^{89}(n,\gamma)Y^{90m}$ (thermal and epicadmium neutrons) and $Nb^{93}(n,\alpha)Y^{90m}$, and $Zr^{90}(n,p)Y^{90m}$ (14 MeV neutrons).

NUCLEAR REACTIONS

(Including scattering by nuclei)

12186 APPLICATION OF THE VARIATIONAL METHOD TO THE STUDY OF THE STRIPPING REACTION. Yu.V.Tsekhmistrenko.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 561-6 (1958). In Ukrainian.

The physical problem of the potential scattering of a bound complex of particles by the nucleus is examined. An integral expression is derived which possesses stationary properties for a definitely selected part of a true wave-function and does not depend on its normalization. The complete wave-function of the system is determined by this part. The physical sense of this breaking up is particularly simple in the stripping problem. Here the wave-function is split into two parts, one of which describes the deuteron scattering as a whole in the nuclear field, and the other, all the effects connected with the possibility of deuteron fission, the latter function varying in the stationary expression. A certain approximation with one parameter is selected for it, this parameter is calculated, and with certain physically justified assumptions, the amplitude of the stripping reaction is found. However, taking into consideration the possibility of deuteron fission (which distinguishes this study from previous ones, e.g. Butler's theory of 1951) proved to have little effect for the energy region involved (especially at $l_n = 0$).

12187 MEASUREMENT OF ANGULAR AND ENERGY DISTRIBUTIONS OF RADIOACTIVE RECOIL NUCLEI. F.P.Denisov and V.E.Kolesov.

Pribory i Tekh. Eksper. (USSR), 1958, No. 3, 34-6 (May-June). In Russian.

A simple method is described for studying the angular and energy distributions of products of nuclear reactions which lead to the formation of radioactive nuclides. The recoil nuclei emitted

from a target at a given angle are collected on film, the activity of which is then measured with an ordinary beta-counter. [English translation in: Instrum. exper. Tech. (USA), No. 3, 354-6 (May-June, 1958; publ. June, 1959)]. S.J.St-Lorant

Due to Photons

12188 ABSOLUTE CROSS SECTION OF THE REACTION $Cu^{63}(\gamma,n)Cu^{62}$ FOR LITHIUM GAMMA RAYS.

S.Yasumi, M.Yata, K.Takamatsu, A.Masaike and Y.Masuda.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1913-19 (Nov., 1960).

The cross-section of the reaction was measured in order to discover some causes of the existing discrepancy between values measured by bremsstrahlung and by nuclear gamma rays. Experimental procedures used in this experiment were much improved as compared with those used in previous measurements performed in the laboratory for the same purpose. The present results were as follows:

$$\sigma_{Li-\gamma} = 62 \pm 4 \text{ mb for Li gamma rays,}$$

and

$$\sigma_{17.6} = 76 \pm 5 \text{ mb for } 17.6 \text{ MeV } \gamma\text{-rays.}$$

This value is about 30% lower than the average cross-section value determined by the photon difference method in several bremsstrahlung experiments. Therefore, it is suggested that the modified spectrum method proposed by Penfold and Leiss [Analysis of Photo Cross Section (Physics Research Laboratory University of Illinois, 1958)] might eliminate not only the above-mentioned discrepancy but also the discrepancy between theoretical and experimental values in the form

$$\sigma_{-2} \equiv \int \sigma E^{-2} dE,$$

as pointed out by Levinger (Abstr. 340 of 1958).

12189 FINE STRUCTURE OF THE $N^{14}(\gamma,n)N^{13}$ ACTIVATION CURVE. II. N.Mutsuro, K.Sato and M.Mishina.
J. Phys. Soc. Japan, Vol. 15, No. 2, 358 (Feb., 1960).

The authors previously reported eight discontinuities (Abstr. 2206 of 1961) in the activation curve of the reaction $N^{14}(\gamma,n)$ when the neutron yield was plotted as a function of bremsstrahlung maximum energy. These results are extended to a higher energy region from 14.7 to 19.5 MeV and three new breaks were observed at 16.35, 18.05 and 19.10 MeV. Relative cross-sections are given for the resonances corresponding to these discontinuities, assuming that they are of equal width, and the results compared over the energy range from 11 to 20 MeV with the gross resonance structure found by King et al. (Abstr. 2679 of 1960). The resonances at 16.35, 18.05, and 19.10 MeV correspond to compound states in N^{14} probably with odd parity and possible spins 0, 1 or 2, assuming that the photodisintegration proceeds by an electric dipole transition from the 1^+ N^{14} ground state. R.E.Meads

Due to Nucleons

12190 INVESTIGATION OF THE MECHANISM OF HIGH ENERGY NUCLEON–NUCLEUS INTERACTION.

G.Bozóki, E.Fenyves, E.Gombosi and P.Surányi.
Nuovo Cimento (Italy), Vol. 20, No. 3, 429-37 (May 1, 1961).

Nuclear interaction of 9 GeV protons with emulsion nuclei was investigated. A composite nuclear interaction was built up from the individual events and the angular and energy distribution of identified shower particles were measured. From these data the mean value of the inelasticity coefficient as well as the mean number of nucleons struck in a proton–nucleus collision was calculated for an "average" emulsion nucleus. It is shown by comparing the experimental results with those found for nucleon–nucleon collision at 6.2 GeV that the nucleon–nucleus interaction is better described at these energies by the cascade model than by the tunnel model. From this the mean life of the excited state of a colliding nucleon–nucleon system was estimated to be less than 3×10^{-23} sec.

Due to Protons

12191 POLARIZATION OF PROTONS SCATTERED FRO COMPLEX NUCLEI.

S.Yamabe, M.Kondo, S.Kato, T.Yamazaki and J.Ruan.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2154-8 (Dec., 1960).

The experimental results for the angular dependence of pa ization of elastically scattered protons from C at 14 and 16 M the polarization at 45° laboratory angle in the elastic scatterir 12 target nuclei at the energy of 12 ~ 17 MeV are described. Qualitative agreement with the calculation in terms of optical potential with spin–orbit interaction is obtained for elastic sc of protons by carbon.

12192 ELASTIC AND INELASTIC SCATTERING OF PRO FROM CARBON NUCLEUS FROM 6.5. TO 16 MeV.

Y.Nagahara.
J. Phys. Soc. Japan, Vol. 16, No. 2, 133-47 (Feb., 1961).

Angular distributions and excitation functions of C^{12} (p,p) (Q = 0) and C^{12} (p,p') C^{12*} (Q=-4.43 MeV) reactions were inve gated with the bombarding energy from 6.5 to 16 MeV and fron to 16 MeV, respectively, by the I.N.S. variable energy cyclotr Though the angular distributions were found to vary gradually energy, several distinct anomalies were observed. Especially T_p = 9.1 MeV, a very sharp anomaly was found for the elastic scattering. Around T = 10.5 MeV, a large anomaly of a comp nature was found [which had been reported by Braid and Yntem Bull. Amer. Phys. Soc., Ser. II, Vol. 3, 188 (1958); Vol. 4, 17 where the angular distributions of the elastic and inelastic sca varied violently. Rather strong correlations were observed be the elastic and inelastic (Q = −4.43 MeV) scattering. Observe anomalies were found to be closely related to the levels of the compound nucleus N^{13}.

12193 10 MeV PROTON REACTION CROSS SECTIONS COMPARED WITH SURFACE AND VOLUME ABSC TION OPTICAL MODELS OF THE NUCLEUS.

R.D.Albert and L.F.Hansen.
Phys. Rev. (USA), Vol. 123, No. 5, 1749-50 (Sept. 1, 1961).

(p,n) cross-sections were measured at 9.85 MeV for self-supporting thin targets of Al, Tl, Fe, Co, Ni, Cu^{63}, Cu^{65}, Rh, Ag Ta, and Au. (p,2n) contributions were calculated using the sta tical model of the nucleus for Rh, Ta, Ag, and Au. Charged-pa emission was assumed negligible in Ta and Au because of sma Coulomb penetrabilities. Approximate proton reaction cross-sections were obtained by adding (p,n) and (p,2n) cross-sectio (p,p') and (p,α) cross-sections previously reported by Meyer Hintz (Abstr. 20432 of 1960). These results were compared wi volume absorption and surface absorption optical-model calcul of proton reaction cross-sections. The parameters for both m calculations were obtained prior to this work by fitting proton elastic scattering and polarization data. The results indicate a surface-absorption potential rather than a volume-absorption potential.

12194 STRUCTURE OF GIANT RESONANCE IN $Al^{27}(p,\gamma)$ REACTION.

M. Kimura, K.Shoda, N.Mutsuro, T.Tōhei, K.Sato, K.Kuroda, K.Kuriyama and T.Akiba.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1128-9 (June, 1960).

Measurements of 90° yield of γ-rays resulting from the ca in Al^{27} of photons with energies from 7.5 to 14.7 MeV were mad and the spectrum of γ-rays resulting from capture of 0.3-0.5 μ proton beams by Al foil targets 9μ thick (99.6% Al) at a 45° glan angle was compared with the background spectrum without the target. By plotting the relative cross-section for the $Al^{27}(p,\gamma$ (where γ_0 leads to the ground state -11.58 MeV and γ_1 to the fir excited state -11.78 MeV) against the proton energy, a full struc of giant resonance was demonstrated, with a ~4 MeV width. T giant resonance is discussed in relation to the results of Gemm et al. (Abstr. 8579 of 1959). L.Mor

12195 EXCITATION FUNCTION FOR THE REACTION $B^{11}(p,n)C^{11}$ UP TO E_p = 15 MeV AND ENERGY LE OF C^{12}.

M.Furukawa, Y.Ishizaki, Y.Nakano, T.Nozaki, Y.Saji and S.Tana
J. Phys. Soc. Japan, Vol. 15, No. 12, 2167-20 (Dec., 1960).

The excitation function for the $B^{11}(p,n)C^{11}$ reaction was me by the activation method with improved energy resolution for t proton energies ranging from 4.7 to 15.0 MeV. The excitation

on exhibited rather clear peaks at proton energies of 8.5, 9.9, 11.5 and 13.6 MeV in the laboratory system and a broad peak energy region between 13.8 MeV and 14.5 MeV. A considerable er of uncertain peaks were also observed. The excitation ion for the $O^{16}(p,\alpha)N^{13}$ reaction was also obtained above 9.7 MeV.

12196 PROTON INTERACTIONS WITH Cu^{63} AND Cu^{65}.
J.Benveniste, R.Booth and A.Mitchell.
. Rev. (USA), Vol. 123, No. 5, 1818-23 (Sept. 1, 1961).
Elastic scattering of protons from Cu^{63} and Cu^{65} was observed everal energies in the range 7 to 12 MeV. When plotted as the -to-Rutherford, the isotopic differential cross-sections exhibit ift which is two to three times larger than would be expected if nuclear radius were governed by the $A^{1/3}$ law. Inelastic scatg and (p,α) cross-sections were measured to contribute to vledge of the reaction cross-sections and to an unambiguous cal-model analysis.

12197 HIGH-RESOLUTION MEASUREMENTS OF THE $O^{16}(p,\alpha)N^{13}$ EXCITATION FUNCTION.
.Hill, E.L.Haase and D.B.Knudsen.
s. Rev. (USA), Vol. 123, No. 4, 1301-9 (Aug. 15, 1961).
The $O^{16}(p,\alpha)N^{13}$ activation cross-section was measured from o 18 MeV with an energy resolution of 30 keV. The results are entially the same as obtained by Whitehead and Foster (Abstr. 6 of 1959) and Rouse (1958), using poorer resolution except for very narrow resonance. As the proton energy increases ough this resonance, the cross-section first rises 7% to a ximum, then drops 33% to a minimum, and finally rises 6%. peak and valley have a width at half-maximum of 30 keV and the k and valley are separated by 60 keV. The proton energy at fway down the drop was determined, using the limp-wire hnique, to be 14.600 ± 0.020 MeV. This resonance is well suited calibration purposes. A qualitative interpretation of the results made using the "cluster model."

12198 FORMATION OF N^{13} IN HIGH-ENERGY NUCLEAR REACTIONS. I.Dostrovsky, Z.Fraenkel and J.Hudis.
ys. Rev. (USA), Vol. 123, No. 4, 1452-8 (Aug. 15, 1961).
Experimental cross-sections are reported for the formation N^{13} in the bombardment of Zn, In, Pb, and U with protons of), 1.9, and 2.9 BeV energy. These values are compared with eoretical N^{13} emission cross-sections for proton energies of 84 and 1.84 BeV. The calculations are based on the evaporation odel. The previously described Monte Carlo procedure was odified in order to obtain better statistical accuracy for the lculated N^{13} cross-sections. Previously computed emission cross-ctions for He^6, Li^8, and Be^7 were also recomputed using the odified Monte Carlo procedure. The cross-sections were comput-d for three different formulations of the interaction radius. Good t with the experimental He^6, Li^8, and Be^7 cross-sections is obtain-d when the smaller values for the interaction radius are used. owever, the fit with the experimental N^{13} values is not good enough exclude processes other than evaporation as contributing to the xperimentally observed cross-sections.

LOWER EXCITED STATES IN P^{29} FROM THE $Si^{28}(p,\gamma)P^{29}$ EACTION. See Abstr. 12159

THE REACTION $^{28}Si(p,\gamma)^{29}P$. See Abstr. 12158

12199 DEUTERONS FROM HIGH-ENERGY PROTON BOMBARDMENT OF MATTER. S.T.Butler and C.A.Pearson.
hys. Rev. Letters (USA), Vol. 7, No. 2, 69-71 (July 15, 1961).
Suggests that deuterons emitted from targets during 25 BeV roton bombardment and in cosmic ray interactions result from ie pairing of two cascade nucleons with small relative momenta the strong forward peak. Calculations agree with experimental esults at lower energies, but predict too many deuterons at high nergies. Better agreement would be obtained for a smaller ffective nuclear potential than that of Duerr (Abstr. 7147 of 1956; 961 of 1958). Hagedorn's theory (Abstr. 20245 of 1960) is com-ared and criticized. E.J.Burge

12200 SPALLATION REACTIONS IN THORIUM DUE TO 150 AND 82 MeV PROTONS.
.Lefort, G.N.Simonoff and X.Tarrago.
uclear Phys. (Internat.), Vol. 25, No. 2, 216-47 (May, 1961).
Spallation reactions of thorium by 150 MeV and 83 MeV protons ere studied by radiochemical isolation of Pa, Th, Ac and Ra isotopes and measurements of absolute cross-sections. Calculations were based on the Serber–Jackson model of nuclear reactions by direct interaction and neutron evaporation. Fission–evaporation competition at each step of evaporation was assumed. The agreement is very satisfactory for (p,pxn) reactions. However, experimental values are nearly twice the calculated ones for radium and actinium. Several reasons are given to explain this discrepancy. Direct interaction occurs also for alpha-fragments, deuterons and tritons. Cross-sections for alpha-particle and triton production were measured at various energies. The formation of tritium is explained in terms of indirect pick-up.

Due to Neutrons

12201 ELASTIC SCATTERING OF 2.8 MeV NEUTRONS BY HEAVY NUCLEI.
V.I.Strýzhak, I.A.Tot'skýi and V.V.Bobýr.
Ukrayin, fiz. Zh. Dodatok, (USSR), Vol. 3, No. 2, 9-13 (1958).
The cross-sections for elastic scattering on mercury, lead and bismuth, were measured over the range 25° to 152°. A spherical ionization chamber filled with methane was employed as the detector.

12202 ANGULAR DISTRIBUTION OF 2.8 MeV NEUTRONS ELASTICALLY SCATTERED BY THE NUCLEI OF LIGHT ELEMENTS. V.V.Bobýr, V.I.Strýzhak and I.A.Tots'kýi.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 836-7 (1958). In Ukrainian.

12203 INELASTIC SCATTERING OF NEUTRONS BY THE TIME-OF-FLIGHT METHOD.
K.Tsukada, S.Tanaka and M.Maruyama.
J. Phys. Soc. Japan, Vol. 16, No. 2, 166-75 (Feb., 1961).
Neutrons scattered by Ti, Fe, Zn and Se were observed by the time-of-flight technique in the energy range of 3.4 to 4.6 MeV. The inelastic scattering cross-sections for the excitations of the 1st, 2nd and 3rd levels of these elements except Se, were obtained. The excitation functions of these levels were compared with those calculated with a formula which was made by modifying Hauser–Feshbach's formula (Abstr. 7577 of 1952) so as to be used without detailed knowledge about the levels of high excitation. Agreement was fairly good except for the case of the 2nd and 3rd levels of Zn, where calculated values were about twice as large as experimental values. Thus it was concluded that the compound-formation process is considered to predominate over the direct process in these energy and mass regions.

12204 GAMMA SPECTRA DUE TO INELASTIC SCATTERING OF NEUTRONS.
I.F.Barchuk, M.V.Pasechnýk and Yu.A.Tsibul'ko.
Ukrayin fiz. Zh. (USSR), Vol. 3, No. 1, 53-62 (1958). In Ukranian.
Using a scintillation spectrometer with a NaI:Tl crystal (60 mm in diameter and 50 mm in height) and a photomultiplier (FEU-1B) measurements were made of the γ-ray spectra excited by the inelastic scattering of 2.8 MeV neutrons on Mg, Al, Fe, Cu, Sn and Sb. A rough estimation is made of the γ-line intensities for each element separately. The neutrons were obtained from the $D(d,n)He^3$ reaction in a low-voltage accelerator (140-150 kV) with a high-frequency ion source. An adsorption target was employed in order to reduce the γ-ray background. The pulse-height distributions were measured with a 50-channel amplitude analyser with magnetic drum memory. The spectrometer resolution was 6.5-7% for Co^{60} γ-rays (1.17 and 1.33 MeV). Annular geometry was applied in the experiment.

12205 FAST [MONOENERGETIC] NEUTRON CAPTURE CROSS-SECTIONS OF MAGIC AND ADJACENT NUCLEI.
Yu.V.Hofman.
Ukrayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 14-20 (1958).
In Ukrainian.
These cross-sections were measured by the activation method at neutron energies of 2.5, 3.1 and 4 MeV. For standard cross-sections, those of I^{27} were taken from the published data and were chosen as 51, 44 and 37 mb respectively, at the energies mentioned. The results obtained are given as atomic mass functions and compared with other values.

12206 5 BeV NEUTRON CROSS SECTIONS IN HYDROGEN AND OTHER ELEMENTS.
J.H.Atkinson, W.N.Hess, V.Perez-Mendez and R.Wallace.
Phys. Rev. (USA), Vol. 123, No. 5, 1850-9 (Sept. 1, 1961).
The neutron total and reaction cross-sections were measured

at 5.0 BeV. Transmission measurements were made in good and poor geometry. The high-energy neutron beam was produced when the Bevatron circulating proton beam struck a copper target. Neutrons were identified by their production of pions in a beryllium block. The pions were then detected by a counter telescope including a gas Cherenkov counter. The threshold of this gas Cherenkov counter defined the mean effective neutron energy at 5.0 ± 0.4 BeV, with the half-intensity points of the neutron energy distribution at 5.9 and 4.2 BeV. The cross-sections measured for the various elements are (in millibarns):

	Pb	Sn	Cu	Al	C	H
σ_t	2534 ± 105	1986 ± 88	1158 ± 34	614 ± 33	319 ± 20	33.6 ± 1.6
σ_r	1670 ± 79		586 ± 25	381 ± 27	235 ± 16	

The 5 BeV total cross-sections are 20% below the total cross-sections measured at 1.4 BeV by Coor et al., (Abstr. 7377 of 1955), whereas the reaction cross-sections remain essentially constant as a function of energy above 300 MeV. This behaviour of the cross-sections can be interpreted by a generalized diffraction theory developed by Glassgold and Grieder (Abstr. 6139 of 1959).

12207 CROSS SECTIONS FOR THE (n,2n) REACTION IN C^{12}, N^{14}, O^{16} AND F^{19} IN THE ENERGY RANGE 10-37 MeV. O.D.Brill', N.A.Vlasov, S.P.Kalinin and L.S.Sokolov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 55-7 (Jan. 1, 1961). In Russian.

For abstract, see Abstr. 10021 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 24-6 (July, 1961)].

12208 TOTAL CROSS SECTIONS OF CARBON, OXYGEN, FLUORINE AND THORIUM FOR FAST NEUTRONS.
K.Tsukada and T.Fuse.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1994-2000 (Nov., 1960).

The total cross-sections were measured in the energy range of 3.3 to 5.0 MeV. Measurements were made with a good-geometry arrangement and an energy resolution of about 20 keV, using a neutron detector which had a high efficiency and a good characteristic for γ-ray discrimination. For C, O and F, several resonances in the cross-sections were analysed to give spin assignments. For Th, a giant resonance was observed at 4.2 ± 0.2 MeV.

12209 (n,d) AND (n,p) REACTIONS NEAR Z = 50.
R.A.Peck, Jr.
Phys. Rev. (USA), Vol. 123, No. 5, 1738-46 (Sept. 1, 1961).

An emulsion study is reported of charged particles produced by 14 MeV neutron bombardment of Rh^{103}, In^{115}, Sn^{116}, Sn^{120}, Sb, and Te. For all but Te (no detectable yield) cross-sections and spectra are presented, with distributions over the first 40° of laboratory angle of energy groups from Rh, In, and Sb. Contrary to an assumption common in earlier work, there is strong evidence that the (n,d) reaction contributes strongly. Five peaks among the Rh, In, and Sb spectra are identified with pickup transitions, the angular distributions conforming to Butler curves for uniquely predicted (2) or reasonable (3) l values. These values are consistent with target proton orbitals in all five cases. The wide (n,np) group is found at the expected energy in the Rh, In, Sn^{116} and Sb spectra; its angular distribution is anomalous for Rh but displays the expected isotropy in the other three cases. Up to at least 6 MeV excitation the (n,p) gross structure is dominated by single-particle effects, the uncontaminated (n,p) yield obeying predictions of the Nilsson model as to spectral concentration and angular distribution; the low collective levels excited in (p,p') are not observed. Systematic behaviour of the direct-interaction radius for (n,d) and (n,p) and of the reduced width for pickup are found to be reasonable. It is inferred that the parent state for proton pickup with low residual excitation is almost purely a single-particle state in the case of Sb, and has a strong single-particle character in Rh and a very weak one in In.

Due to Mesons and Hyperons

12210 NUCLEAR DE-EXCITATION FOLLOWING MUON CAPTURE AND THE BOUND MUON DECAY ANOMALY.
F.Chilton.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 31-4 (July 1, 1961).

Experiments to measure the rate of negative muon decay when the muon is bound in the Coulomb field of the nucleus have shown that the rate rises appreciably above the free decay rate for muons bound to nuclei with Z between 20 and 30. This is in contradiction with the theory which predicts a gradual fall in the rate with increasing Z. The author shows that the anomaly could be exp if conversion electrons from γ-rays resulting from nuclear de excitation following muon capture had been detected in 1% of t muon capture events, and mistaken for decay electrons. A pos mechanism is discussed which would also explain why the effe disappears for Z ≥ 30. J.D.

Due to Deuterons

12211 THE $B^{10}(d,n)C^{11}$ REACTION.
A.N.James, A.T.G.Ferguson and C.M.P.Johnson.
Nuclear Phys. (Internat.), Vol. 25, No. 2, 282-91 (May, 1961).

Neutron groups from the reaction $B^{10}(d,n)C^{11}$ were studie deuteron energies of 1.2, 3 and 4 MeV using time-of-flight tec niques. The results are compared with those for the $B^{10}(d,p)$ reaction and with Butler stripping theory for the intermediate coupling shell model.

12212 $C^{14}(d,n)N^{15}$ REACTION.
R.Chiba.
Phys. Rev. (USA), Vol. 123, No. 4, 1316-21 (Aug. 15, 1961).

Differential cross-sections for ground-state neutrons fro $C^{14}(d,n)N^{15}$ reaction were measured at E_d = 3.53 MeV and 2.78 by a neutron spectrometer. A stripping peak implying $l_p = 1$ observed. The excitation function of the ground-state neutron measured from $E_d = 1.2$ MeV to $E_d = 3.53$ MeV. A number of resonances were found corresponding to virtual states of N^{16}. angular distributions of neutrons associated with the 5.28, 5.3 doublet (unresolved) and 6.33 MeV levels of N^{15} were measure by photographic emulsion technique. A stripping peak charact of $l_p = 0$ corresponds to the unresolved doublet, and $l_p = 1$ to th 6.33 MeV state. The excitation function for all neutrons from $(d,n)N^{15}$ was measured both by "slow" and "fast" neutron coun Several possible slow-neutron thresholds were found corresp to excited states of N^{15}. The sensitivity of the slow-neutron t hold technique was checked by the $O^{16}(d,n)F^{17}$ reaction. Accur values of these thresholds are reported.

12213 DIFFERENTIAL CROSS-SECTIONS FOR THE N^{14}(GROUND STATE REACTION AT THE DEUTERON ENERGY OF 16 MeV.
S.Morita, N.Kawai, N.Takano, Y.Goto, R.Hanada, Y.Nakajima, S.Takemoto and Y.Yaegashi.
J. Phys. Soc. Japan, Vol. 15, No. 2, 361-2 (Feb., 1960).

Results are presented for the angular distribution of grou state protons from the $N^{14}(d,p)N^{15}$ reaction at deuteron energi 16.2 and 16.7 MeV. The results are compared with stripping and are best fitted to Bhatia's formula with $r_0 = 7.0 \times 10^{-13}$ c They are further compared with those for the $C^{12}(\alpha,p)N^{15}$ reac nearly the same excitation energies of the compound nucleus and some resemblance is noted. The cross-sections at 90° an backward angles may be due in part to compound nucleus form although the forward-angle results are explained by stripping R.E.

12214 THE $N^{14}(d,n)O^{15}$ REACTION IN THE ENERGY RA FROM 1.5 TO 2.9 MeV.
S.Morita, N.Kawai, Y.Gotô, T.Maki and M.Mukae.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2170-5 (Dec., 1960).

The angular distributions of neutrons emitted from the $N^{14}(d,n)O^{15}$ reaction were investigated by means of the neutron detector made of a thin plastic scintillator to eliminate the α- background, at deuteron energies of 1.53, 1.72, 1.96, 2.24, 2.54, 2.65_s, and 2.90 MeV. The results were compared with stripping theory including the heavy particle stripping, and qu agreements were obtained. The excitation curve of this react also estimated and compared with those of the $N^{14}(d,p)N^{15}$ and $N^{14}(d,\alpha)C^{12}$ reactions. The excitation curves of the $N^{14}(d,n)$ a $N^{14}(d,p)$ reactions show similar resonance-like structures, w that of the $N^{14}(d,\alpha)$ reaction shows somewhat different behavi

12215 ON THE PROTONS FROM THE $N^{14}(d,p)N^{15}$ REACT N.Kawai.
J. Phys. Soc. Japan, Vol. 16, No. 2, 157-65 (Feb., 1961).

Angular distributions for the reaction were investigated a deuteron energies ranging from 1.5 to 3.2 MeV. Measurement were carried out in the angular range from 0 to 165 degrees a

tn vals of 15 degrees. The results for the $N^{14}(d,p)N^{15}$ ground state ction showed generally a forward peak, as was expected from eron stripping, and a considerable rise in backward directions. e experimental data were analysed with the heavy particle ping theory and parameters adjusted to get a best fit were ined. With the exception at forward directions, the main feature gular distributions was found to be very similar to that for the n)O^{15} ground state reaction, which is the mirror reaction, at ame deuteron energies. At forward directions proton yields the $N^{14}(d,p)N^{15}$ reaction were substantially larger than neutron ds from the $N^{14}(d,n)O^{15}$ reaction. Angular distributions for the excited doublet state reaction were found to be nearly isotropic, a slight peak was observed at about 60 degrees similarly to all eron energies. Total cross-sections for both state reactions e also estimated. Excitation functions for the $N^{14}(d,p)N^{15}$ and d,n)O^{15} ground state reactions showed similar behaviour, having e resonance-like structures.

ıe to Alpha-particles

12216 THE ELASTIC SCATTERING OF 29 MeV ^{3}He-PARTICLES BY Cl, Kr AND Xe.
guilar, A.García, J.B.A.England, P.E.Hodgson and W.T.Toner.
:lear Phys. (Internat.), Vol. 25, No. 2, 259-65 (May, 1961).

Angular distributions for the scattering of 29 MeV He^3-particles Cl, Kr and Xe were measured using a photographic plate method. solute differential cross-sections for elastic scattering are given the centre-of-mass system in the angular range 14° to 80°. The erimental results are analysed in terms of the optical model of interaction and best fit parameters of this model are obtained.

12217 A STUDY OF THE (^{6}He,d) REACTIONS LEADING TO ^{11}C AND ^{12}C. S.Hinds and R.Middleton.
oc. Phys. Soc. (GB), Vol. 78, Pt 1, 81-91 (July, 1961).

The reactions $B^{10}(He^3,d)C^{11}$ and $B^{11}(He^3,d)C^{12}$ were studied, ing magnetic analysis, at a bombarding energy of 9.84 MeV. A level in C^{11} at 6.345 ± 0.010 MeV excitation was observed. uteron angular distributions leading to the ground and first five cited states of C^{11} were measured, and an attempt was made to these with stripping curves. Absolute proton reduced widths for e C^{11} levels were extracted. Using the $B^{11}(He^3,d)$ reaction, the ergy levels of C^{12} between 9 and 15 MeV were studied. Natural dths of levels at 10.84, 11.82 and 13.38 MeV were measured to be 0, 300 and 700 keV respectively. Stripping analyses of the uteron angular distributions yielded l-values of 2, 0, 0 and 1 spectively for the states of C^{12} at 9.63, 10.84, 11.82 and 12.70 MeV. solute proton reduced widths and also α-particle reduced widths, om the measured total widths, were extracted for some levels of .

12218 NEUTRONS AND GAMMA RAYS FROM THE BOMBARDMENT OF O^{16} BY He^3. K.L.Dunning and J.W.Butler.
hys. Rev. (USA), Vol. 123, No. 4, 1321-5 (Aug. 15, 1961).

The threshold energy for the $O^{16}(He^3,n)Ne^{18}$ reaction was easured. The value obtained, 3.811 ± 0.015 MeV, determines the ass of Ne^{18} to be 18.011446 ± 0.000014 a.m.u. (O^{16} standard, 1960 ass tables). The slow-fast ratio method for the observation of eutron thresholds was employed at bombarding energies from the round-state threshold to 5.6 MeV, corresponding to a region of citation in the residual nucleus from zero to 1.5 MeV. No excited ates in Ne^{18} were identified. The bombardment of O^{16} by He^3 also oduced the reactions $O^{16}(He^3,p)F^{18}$ and $O^{16}(He^3,\alpha)O^{15}$. Energy pectra were obtained by means of a scintillation spectrometer for mma-rays resulting from certain transitions in F^{18} and O^{15}. For 5 MeV He^3 particles impinging on a 1 MeV thick target of TiO_2, mma-rays of the following energies were observed and attributed F^{18}: 0.652 ± 0.007, 0.939 ± 0.005, 1.041 ± 0.005, 1.17 ± 0.01, 61 ± 0.02, 1.68 ± 0.02, 2.09 ± 0.01, 2.51 ± 0.01, 2.65 ± 0.05, 06 ± 0.05, 3.35 ± 0.10?, and 3.84 ± 0.10 MeV. The following mma-rays were also observed and attributed to O^{15}: 5.25 ± 0.05, 22 ± 0.10, and 6.87 ± 0.10 MeV.

12219 REACTIONS OF IRON-54 WITH ALPHA-PARTICLES. S.Tanaka, M.Furukawa, S.Iwata, M.Yagi, H.Amano, d T.Mikumo.
Phys. Soc. Japan, Vol. 15, No. 9, 1547-51 (Sept., 1960).

Excitation functions for the (α,p), (α,n), (α,pn), $(\alpha,2n)$, $(\alpha,p2n+\alpha,3n)$, $(\alpha,\alpha n)$, $(\alpha,\alpha pn)$ and $(\alpha,\alpha 2n)$ reactions on Fe^{54} were easured by the activation method using a "stacked-foil" technique, the alpha-particle energies ranging from 10 MeV to 40 MeV. The predominance of proton emission over neutron emission was observed. The ratios of $\sigma(\alpha,p)/\sigma(\alpha,n)$ and $\sigma(\alpha,pn)/\sigma(\alpha,2n)$ in the region of maximum yield were found to be 3.4 and 60, respectively. The ratio of $\sigma(\alpha,\alpha pn)/\sigma(\alpha,\alpha 2n)$ at 40 MeV was about 180. A small "knee" was observed at the incident alpha-particle energy of about 20 MeV in the excitation function for the $(\alpha,2n)$ reaction. The total reaction cross-section was found to agree with the value calculated from continuum theory for a nuclear radius constant r_0 of 1.7×10^{-13} cm assuming a nuclear square well potential.

12220 EXCITATION FUNCTIONS FOR ALPHA-PARTICLE REACTIONS ON Fe^{56} AND Fe^{57}. S.Tanaka, M.Furukawa, S.Iwata, M.Yagi, H.Amano and T.Mikumo.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2125-8 (Dec., 1960).

Excitation functions for the (α,pn), $(\alpha,p2n)$, $(\alpha,3n)$ and $(\alpha,\alpha pn)$ reactions on Fe^{56} and the $(\alpha,\alpha p)$ reaction on Fe^{57} were measured by the activation method using a stacked-foil technique, the α-particle energies ranging from 17 to 40 MeV. The measured excitation functions for the α-particle reactions on Fe^{56} (present work) were compared with those for the proton reactions on Co^{59} (Sharp et al. Abstr. 3209 of 1956); the compound nucleus Ni^{60} being the same for two cases. The comparison gives a test of the validity of compound nucleus theory. The ratios of corresponding cross-sections seem to agree well with the theory (except in the case of resulting Co^{57}). However, it may be seen that the two curves corresponding to the same residual nucleus in each case do not entirely coincide in energy.

12221 REACTIONS OF NICKEL WITH ALPHA-PARTICLES. S.Tanaka.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2159-67 (Dec., 1960).

Excitation functions for the α-particle induced reactions on Ni^{58}, Ni^{60}, Ni^{61}, Ni^{62} and Ni^{64} were measured at incident energies up to 40 MeV. The sum of the measured cross-sections for Ni^{58} appears to agree with the total reaction cross-section calculated from the continuum theory for $r_0 = 1.7 \times 10^{-13}$ cm. The sum almost agrees with the optical-model analysis of reaction cross-section for alpha-particles by Igo (Abstr. 1419 of 1960), but his prediction seems to give a little higher value. In the excitation function for the $(\alpha,\alpha n)$ reaction on Ni^{58}, there is a small "knee" immediately after the effective threshold (around 23 MeV). The α-particle reactions on Ni^{60} were compared with the proton reactions on Cu^{63}, the compound nucleus Zn^{64} being the same for the two cases. The prediction from the compound nucleus theory seems to hold roughly, and it seems inadequate to discuss strictly whether the discrepancy in energy is significant. The same is observed in the comparison between the α-particle reactions on Ni^{63} and the proton reactions on Cu^{65}.

12222 SCATTERING OF 915 MeV α-PARTICLES FROM CARBON AND HELIUM: DIRECT EVIDENCE FOR α-PARTICLE CLUSTERING IN NUCLEI. T.J.Gooding and G.Igo.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 28-30 (July 1, 1961).

Counters were used to detect quasi-elastic $\alpha-\alpha$ scattering in $C^{12}(\alpha,2\alpha$ reaction) at 915 MeV. By measuring the energies of the two outgoing α-particles and the angular correlation between them it was established that the reaction proceeds via a direct collision between the incident α-particle and an α-particle cluster in the nucleus. The differential cross-section was measured at laboratory angles of 17°, 26° and 45° and the results are given below compared with elastic $\alpha-He^4$ scattering which was also measured.

$\theta_{lab.}$	$d\sigma/d\Omega$ μb/steradian	
(deg.)	Helium	Carbon
17°	165 ± 35	287 ± 150
26°	22 ± 11	86 ± 50
45°	0	0

J.D.Dowell

Due to other Particles and Nuclei

12223 EXCITATION FUNCTIONS FOR LITHIUM-6 INDUCED REACTIONS ON ALUMINUM-27.
I.M.Ladenbauer, I.L.Preiss and C.E.Anderson.
Phys. Rev. (USA), Vol. 123, No. 4, 1368-72 (Aug. 15, 1961).

Excitation functions for a number of Li^6- induced reactions on Al^{27} were studied using stacked-foil techniques and a Li^6 ion beam. Excitation functions corresponding to radioactive residual

nuclei P^{32}, P^{30}, Si^{31}, Al^{29}, Al^{28}, Mg^{27}, Na^{24}, and Na^{22} were measured in the Li^6 energy range from 1 to 63.3 MeV. The data strongly suggest that the P^{32}, P^{30}, and Si^{31} result from compound system processes and the Na^{22} and Na^{24} from a predominant direct knock-out process. In the cases of Al^{28} and Al^{29} both compound system and direct pickup reaction amplitudes contribute to the reaction yield.

12224 COMPOUND NUCLEUS PROCESSES IN THE REACTIONS BETWEEN COMPLEX NUCLEI. T.Kammuri.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 235-46 (Feb., 1961).

A modification is made in the statistical theory of nuclear reactions so as to take account of the angular momenta of the nuclear states relevant in the reactions. Since the average values of the angular momenta of the compound nuclei formed by different projectiles at the some excitation energy will be different, various aspects of the decay process will also depend on the incident particles. For this purpose it is essential to take the spin dependence of the nuclear level density not as $(2I + 1)$, but $(2I + 1)\exp[-I(I + 1)/2cT]$. In this paper, the energy spectra of emitted particles are treated. The average kinetic energy of evaporating neutrons from a high-spin nucleus becomes higher than twice the nuclear temperature T. It is shown that the anomalies found in the branching ratios or excitation functions in the heavy-ion reactions can be explained by the angular momentum effect. The degree of these anomalies depends sensitively on the nuclear moment of inertia ch^2.

12225 THE RANGE–ENERGY RELATION OF LOW-ENERGY LIGHT IONS IN NUCLEAR EMULSIONS.
Cao Xuan Chuan.
J. Phys. Radium (France), Vol. 21, No. 10, 757-9 (Oct., 1960).
In French.

The range–energy relation for B^{11} and C^{13} in nuclear emulsion was determined experimentally by calculating the energy of the recoil nuclei of (n,α) reactions on O^{16} and N^{14} leading to the ground states from the kinematics of the reaction products. S.J.St-Lorant

Nuclear Fission

12226 DELAYED-NEUTRON STUDIES FROM THE THERMAL-NEUTRON-INDUCED FISSION OF Pu^{241}. S.A.Cox.
Phys. Rev. (USA), Vol. 123, No. 5, 1735-7 (Sept. 1, 1961).

The measured total delayed-neutron yield from Pu^{241}, determined from a comparison measurement between Pu^{241} and U^{235}, is 0.0154 ± 0.0015 neutron/fission. The measured values for the individual group yields and the associated half-lives are: 0.000154 ± 0.00004 n/f, 54.0 ± 1 sec; 0.00365 ± 0.0001 n/f, 23.2 ± 0.5 sec; 0.00275 ± 0.0004 n/f, 5.6 ± 0.6 sec; 0.0062 ± ± 0.0008 n/f, 1.97 ± 0.1 sec; 0.0029 ± 0.0003 n/f, 0.43 ± 0.04 sec. The systematic behaviour of delayed-neutron emission is discussed. The systematic study suggests that the variation of delayed-neutron yield with both mass number and atomic number is influenced more by changes in the fission-product charge distribution than by changes in the fission-product mass distribution.

12227 KINETIC ENERGY EFFECTS IN THE THERMAL NEUTRON FISSION OF U^{235}. T.J.Gooding.
Proc. Phys. Soc. (GB), Vol. 77, Pt 5, 1097-8 (May, 1961).

By means of an apparatus comprising two Au–Si surface barrier semiconductor counters in a back-to-back arrangement, upon one of which detectors 50 $\mu g\ cm^{-2}$ of 93% enriched U^{235} was evaporated, it was possible to measure the mass distribution in the thermal neutron fission of U^{235} in correlation with the total kinetic energy released. It was determined that the ratio of the most probable masses decreases as the total kinetic energy is increased, and that the peak-to-valley ratio increases by more than one order of magnitude over this energy range (155-180 MeV). L.Mordecai

12228 μ^--MESON FISSION OF U^{238}.
A.K.Mikhul and M.G.Petrashku.
Dokl. Akad. Nauk SSSR, Vol. 124, No. 1, 66-8 (Jan. 1, 1959).
In Russian.

A study is reported of 26.975×10^3 stoppings μ^- mesons in plates soaked in uranium acetate; the path lengths of fission fragments are measured. Values of fission probability, Pf, were calculated from the experimentally determined probability, P, and two separate estimates of the probability of atomic captures of μ^- mesons, Pc, according to the expression Pf = P/0.4 Pc were made. It is concluded that the fission of U^{238} by capture of the μ^- mes into one of the optical orbits followed by transitions into the st 2s–2p–1s occurs in a significant number of cases. For the al native process involving nuclear capture through the reaction $\mu^- + p \rightarrow n + \nu$, the estimated value of Pf for Pa^{238} is in fair agr ment with that calculated from the Fermi–Teller law. [Englis translation in: Soviet Physics–Doklady (USA), Vol. 4, No. 1, 9 (Aug., 1959)]. J.W.T

12229 MULTIPOLARITY OF γ-RAY ABSORPTION IN U^{23} REACTION PRODUCED BY $F(p,\alpha\gamma)\ \gamma$ RAYS.
E.Takekoshi.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2129-36 (Dec., 1960).

The multipolarity was investigated by the analysis of the a distribution of 1018 tracks of fission fragments in uranium-impregnated nuclear emulsions. It can be explained by mixing sorts of interaction; electric dipole (E1) and electric quadrupo (E2). The ratio of E2 to E1 absorption cross-section, denoted σ_{fq}/σ_{fd}, was found to be 0.13 ± 0.05. This value is compared w other results with bremsstrahlung. The angular distribution is consistent with those of Baz et al. [International Conference on Peaceful Uses of Atomic Energy (Geneva, September 1958)]; how the analysis and interpretation of the results are different from those of Baz et al.

12230 FISSION OF GOLD WITH 112-MeV C^{12} IONS: A YIE MASS AND CHARGE-DISTRIBUTION STUDY.
H.M.Blann.
Phys. Rev. (USA), Vol. 123, No. 4, 1356-64 (Aug. 15, 1961).

Fission-product cross-sections were measured radiochemi and mass-spectrometrically for gold bombarded with 112 MeV ions. Cross-sections for 43 nuclides were measured for eleme from nickel to barium. Thirty-six yields are either primary fission-product yields (independent yields) or were corrected (with less than 25% correction) so as to represent independent yields. The independent yields were empirically systematized, a yield-mass curve was constructed. The yield–mass curve is compared with the yield–mass curves obtained from the fission bismuth with 22 MeV and 190 MeV deuterons. The yield system indicate that the sum of the mass numbers of complementary fission products is 13 ± 1 a.m.u. less than that of the compound leus, and the sum of the charges of complementary fission prod is 2-units less than that of the compound nucleus. By thermody arguments it is shown that the lost charge was carried by an al particle, not by protons. The most probable charge of the fissi products as a function of mass number was determined empiric and compared with theoretical prediction. The charge-dispersi curve (fraction chain yield versus $Z - Z_p$), may be fitted well the Gaussian $y = \exp[-(Z - Z_p)^2/0.9]/(0.9\pi)^2$. Experimental yi on both sides of $Z - Z_p = 0$ support the symmetry of the charge dispersion curve that many workers have assumed.

12231 STRUCTURE IN THE KINETIC ENERGY SPECTRU OF FRAGMENTS FROM THERMAL-NEUTRON-INDUCED FISSION OF U^{235}.
W.M.Gibson, T.D.Thomas and G.L.Miller.
Phys. Rev. Letters (USA), Vol. 7, No. 2, 65-6 (July 15, 1961).

Pronounced fine structure was observed in the energy spectrum of heavy fragments in coincidence with light fragment energy greater than 100 MeV. Fission yield and average total kinetic energy as a function of mass number are presented. Tw p–n junction detectors were used. E.J.B

12232 PROMPT FISSION YIELDS AND TOTAL KINETIC ENERGY BEHAVIOR FROM TIME-OF-FLIGHT MEASUREMENTS. J.C.D.Milton and J.S.Fraser.
Phys. Rev. Letters (USA), Vol. 7, No. 2, 67-9 (July 15, 1961).

Measurements are reported for U^{233}, U^{235} and Pu^{239}. Mass-energy contours are shown and reveal fine structure at high tot kinetic energies (K.E.). A marked drop (30-40 MeV) was found the total K.E. near symmetry. Two types of fission are suggest symmetrical with highly excited fragments of low K.E., and asymmetric with moderately excited high-K.E. fragments. E.J.B

NUCLEAR POWER STUDIES

12233 FAST REACTORS.
R.G.Palmer and A.Platt.
on: Temple Press (1961) x + 93 pp.
These reactors are still in the experimental stage and decisions ding their possible use for power production will have to be in the course of the next few years. The authors provide erall account of fast reactor technology with a view to advocat- eir adoption. Among the topics covered are: the special lems encountered in a reactor where high burn-up and high r density are economic necessities; methods of calculation xperimental techniques for predicting neutronic performance; d-metal technology and the prediction of heat transfer coeffi- s.

12234 FAST-REACTOR STUDIES IN TREAT—A STATUS REPORT. C.E.Dickerman, E.S.Sowa and D.Okrent.
eonics (USA), Vol. 19, No.4, 114, 116, 118, 121, 150 (April,).
Treat is a pulsed thermal reactor that can produce an integrat- lux transient of 3.8×10^{15}. Either short bursts of half width 0 ms or flat-top bursts with a duration of 1-30 sec can be duced. A test hole 10 cms square contains the experimental sule. This may be a dry opaque capsule, a large container with a window allowing high speed photography or a capsule containing the specimen in a bath of Na. The reactor was used to test the behaviour of fast reactor fuel pins under fault conditions. By March 1961 85 meltdown specimens had been irradiated. Failure of EBR II type pins and Fermi I type pins was investigated. Fermi I pins which contain no sodium could be heated to temperatures above the melting point of the fuel for a short time without failure, but the vaporisation of the sodium band in EBR II pins caused violent ejection of the fuel. At higher temperatures the failure of the Fermi pins indicated that the fuel-alloy escaped under the influence of gravity alone. R.D.Smith

12235 STORED ENERGY IN FUEL-BEARING GRAPHITE.
A.H.Willis, J.M.Baugnet and R.C.De Beukelaer.
J. appl. Phys. (USA), Vol. 32, No. 8, 1622-3 (Aug., 1961).
Fission product damage to graphite with regard to Wigner energy was investigated. A graphite sample was impregnated with UO_2 particles so small in size that virtually all fission products recoiled into the graphite matrix. It was irradiated to 1.3×10^{18} nvt (thermal) at a temperature of 32° C. Post-irradiation calorimetric measurement indicated that 31.2 ± 3.2 cal/g of stored energy had accumulated during exposure to 3 MWD/T. Neutron bombardment alone would have yielded about 1 cal/g of stored energy. Some details are given and the results are discussed. H.E.Schmid

SYNCHROTRON RADIATION IN A D—D REACTOR.
See Abstr. 11938

ATOMIC AND MOLECULAR PHYSICS

ATOMS

12236 THE UNRESTRICTED HARTREE-FOCK METHOD.
W.Marshall.
oc. Phys. Soc. (GB), Vol. 78, Pt 1, 113-19 (July, 1961).
The unrestricted Hartree—Fock method is a convenient method calculating neutron form factors and hyperfine interactions, but ause the method gives wave-functions which are not eigen- ctions of S^2, the validity of it must be questioned. It is shown t the unrestricted Hartree—Fock method gives spin densities ich are approximately correct to first order provided certain change energies are small relative to 'promotion' energies. rthermore, it is shown that the wave-functions obtained must be ed directly and that it is a poor approximation to project out the wanted parts after the energy minimization procedure has been rformed.

12237 "REPULSION OF ENERGY LEVELS" IN COMPLEX ATOMIC SPECTRA. R.E.Trees.
ys. Rev. (USA), Vol. 123, No. 4, 1293-1300 (Aug. 15, 1961).
Rosenzweig and Porter have shown a "repulsion of energy vels" in spacing distributions determined from energy levels in mplex atomic spectra. The present paper extends their work by owing that these spacing distributions can be determined from lculated positions of the levels in these spectra. Since calculated ta are available for spectra where the observed data are scarce incomplete, this partially overcomes limitations imposed by atistical inaccuracy when direct use is made of the observed ta. The equivalence of the two approaches is demonstrated by owing that calculated data for Ta II yield the same spacing stribution as obtained from observed data for Ta II and Re I mbined. These are complex spectra in which a fully developed pulsion effect is present. A similar demonstration of equivalence carried out for spectra of Ru I and Mo I, where the repulsion fect is in an intermediate state of development. The results also dicate that numbers easily evaluated from the radial parameters the theory will indicate roughly the degree of repulsion, replacing some extent the need for an explicit calculation of the spacing stribution.

12238 EXCHANGE POLARIZATION EFFECTS IN HYPERFINE STRUCTURE. D.A.Goodings.
ys. Rev. (USA), Vol. 123, No. 5, 1706-14 (Sept. 1, 1961).
Exchange polarization of core electrons by outer unpaired ectrons is calculated for 10 different atomic configurations of Li, a, K, F, Cl, Be, B, and N in the unrestricted Hartree—Fock (UHF) proximation. Numerical integration techniques were used and accurate conventional Hartree—Fock (HF) wave-functions were also obtained for these configurations. The theory of atomic hyperfine structure in the UHF approximation is developed and the HF and UHF calculated values of the hyperfine coupling constants are compared with available experimental data. The importance of core polarization in solid-state problems is briefly mentioned with particular attention to colour centres. Finally, unsuccessful attempts to calculate core polarization by perturbation expansion methods are discussed.

12239 WAVE FUNCTIONS FOR THE FREE ELECTRON. II. THE INCLUSION OF POLARIZATION AND EXCHANGE. R.G.Breene, Jr.
Phys. Rev. (USA), Vol. 123, No. 5, 1718-23 (Sept. 1, 1961).
For Pt I, see Abstr. 12724 of 1959. The effect of the polarization of the atomic core by the free electron on the free-electron wave-function and the effect of the exchange of the free electron with the bound orbitals on this wave-function are treated by perturbation theory. Polarization must be considered first. Its effect on the atomic charge cloud is introduced through an expansion over the bound wave-functions for the atom in terms of the free-electron separation as a parameter. This parametric treatment of electron separation means one cannot accept the solution at small separations from the nucleus although this is not a serious restriction. From this wave-function the author obtains a polarized Coulomb potential from which a solution for the free-electron function may be obtained using previous programmes. Having solved the free-electron wave equation with the exchange potential terms supposed zero, the author uses this solution to compute the exchange integrals. The equation including these integrals is then solved to obtain approximate wave-functions for free electrons containing both exchange and polarization.

12240 THE TWO-CONFIGURATION APPROXIMATION FOR FOUR-ELECTRON IONS. R.E.Watson.
Ann. Phys. (USA), Vol. 13, No. 2, 250-67 (May, 1961).
One-electron orbitals were obtained by applying the variation principle to the two-configuration $1s^22s^2$-$1s^22p^2$ approximation to ^1S ground state of four-electron ions (Be through Ne^{+6}). These orbitals and the total ion energies and charge densities, obtained with them, are compared with similar results for conventional Hartree—Fock (one-configuration) orbitals. The differences are appreciable. In addition, estimates of the four-electron correlation energies are presented. The current calculations are used in an effort to catalogue the relative importance of the various terms contributing to the correlation energies. A large contribution due

to $1s^22s^2$-$1s^22p^2$ mixing is observed. Its magnitude suggests a type of correlation correction unlike that found in the treatment of two-electron ions.

12241 HARTREE–FOCK ATOMIC WAVE FUNCTIONS FROM Cu^+ to Kr^{+8}. W.W.Piper.
Phys. Rev. (USA), Vol. 123, No. 4, 1281-93 (Aug. 15, 1961).

Hartree–Fock atomic wave-functions were calculated and tabulated for the ground-state configurations of Cu^+ through Kr^{8+}. Interpolation functions for this configuration were also tabulated.

12242 LAMB SHIFT IN THE HELIUM ATOM. C.Schwartz.
Phys. Rev. (USA), Vol. 123, No. 5, 1700-5 (Sept. 1, 1961).

The calculation, first attempted by Kabir and Salpeter (Abstr. 784 of 1958), of the mean excitation energy entering in the Lamb shift of the helium ground state, is re-performed by a quite different approach. The answer, $\ln[k_0/r_y] = 4.370 \pm 0.004$, leaves theory and experiment on the ionization energy of helium in agreement within the experimental uncertainty of $\pm 0.15\ cm^{-1}$. Incidental results are given for the electrostatic polarizability of He and H^- ground states and there is appended a new discussion of the construction of higher angular momentum eigenfunctions for the three-body problem.

12243 APPROXIMATE ANALYTICAL WAVE FUNCTIONS FOR THE $1s^2ns\ ^2S_{1/2}$ STATES OF Li AND Li-LIKE IONS. Z.W.Ritter, R.Pauncz and K.Appel.
J. chem. Phys. (USA), Vol. 35, No. 2, 571-5 (Aug., 1961).

Calculations are made for the $1s^22s$, $1s^23s$, $1s^24s$, $1s^25s$, $^2S_{1/2}$ states of Li and Li-like ions. The functional form used allows for radial correlation in the inner shell and gives sufficient flexibility for describing the outer electron. The energy values obtained for the ground state are the best among calculations which do not introduce interelectronic coordinates or angular correlation. The energy values for the excited states differ by not more than 1% from the experimental values.

12244 THE g_J VALUE OF THE 6^3P_1 LEVEL IN MERCURY. J.N.Dodd.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 65-9 (July, 1961).

A redetermination of the g_J value of the 6^3P_1 level in mercury using the "double-resonance" technique is described. The value is in agreement with recent measurements using the "level-crossing" technique but not with the value obtained in earlier experiments. A weighted mean of all determinations suggests the value $g_J = 1.486\,31 \pm 0.000\,08$.

Rb^{85}–Rb^{86} HYPERFINE-STRUCTURE ANOMALY.
See Abstr. 12149

12245 DEIONIZATION CROSS SECTION FOR OXYGEN. R.G.Breene, Jr.
J. chem. Phys. (USA), Vol. 35, No. 2, 625-9 (Aug., 1961).

Atomic- and free-electron wave-functions are applied to the calculation of the deionization cross-section for O II. The s- and d-wave numerical solutions to the free-electron wave-equation are fitted to Coulomb functions for normalization. This result is used to determine the cross-section for the transitions s wave to 2p orbital and d wave to 2p orbital. An approximate calculation is carried out for the transition to the 3p orbital with the resulting indication that the hydrogen result may reasonably be used. For the contributions from transitions to 3d and higher orbitals the hydrogen cross-sections are adopted. The final result is $198 \times 10^{-21}\ cm^2$ leading to a rate constant for radiative deionization of $218 \times 10^{-14}\ cm^3/sec$.

12246 LINE SHAPES IN THE METHOD OF INTERSECTING ENERGY LEVELS. B.P.Kibble and G.W.Series.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 70-4 (July, 1961).

The first part of this work is a study of the changes of intensity of the resonance fluorescence from mercury vapour as a small magnetic field H is applied either parallel or anti-parallel to the direction of the incident light. The changes follow either a Lorentzian or a dispersion-type function of the Zeeman splitting of the excited state, according to the orientations of polarizer and analyser in the beams of light. In an experiment with an additional oscillatory field at a frequency ω_0, similar curves are observed in the region $H = H_0/2$ (H_0 is the field for which ω_0 is the Larmor frequency). The observations are relevant to a recently developed technique in which intensity changes of this sort are used to make precision measurements in spectroscopy. The Lorentzian line shape is usually observed. The possibility of obtaining line profiles of ot shapes was pointed out by Franken.

12247 SOME PROPERTIES OF RESONANCE LINE-SHAPE FUNCTIONS. D.G.Hughes and D.K.C.MacDonald.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 75-80 (July, 1961).

Some relationships involving line-width and second moment broadened resonance (e.g. nuclear magnetic or electron spin resonance) lines are investigated. It is of particular interest to determine how the properties such as line-shape of a multiply-broadened line depend on the properties of the individual lines. certain cases the shape of the broadened line is the same as tha of the individual lines, and particular attention is paid to this cl of 'self-folding' functions.

12248 NEW EMISSION CONTINUUM OF HELIUM IN THE VACUUM ULTRAVIOLET REGION.
R.E.Huffman, W.W.Hunt, Jr, Y.Tanaka and R.L.Novack.
J. Opt. Soc. Amer., Vol. 51, No. 6, 693 (June, 1961).

Reports the observation of a new continuum in the vacuum u emission of a high pressure He discharge, and investigation of i pressure dependence and intensity ratio relative to the previous discovered He continuum in the 600-900 A region. The new continuum extends from about 1500 A to beyond 2200 A. The di charge used the relaxation oscillations of a 0.06 μF capacitor, charged from a 20 kV d.c. power supply, drawing an average of 150 mA through a 50 kΩ resistor. Source gas pressures from 8 to 800 mm Hg were investigated. The discharge was confined in a 7 mm i.d. 100 mm long quartz capillary, repetition rates bein 300 to 1600 pulses/sec. It is suggested that the continuum is generated by an excited He_2^+ state, since it is definitely associat with the appearance of He II lines. The possible influence of hydrogen and other impurities was checked and found to be negligible. F.R.W

12249 PARAMETERS α AND β IN THE SPECTRA OF THE IRON GROUP. R.E.Trees and C.K.Jørgensen.
Phys. Rev. (USA), Vol. 123, No. 4, 1278-80 (Aug. 15, 1961).

The parameters α and β in the low even configurations of ir group spectra are qualitatively explained as effects of the intera with configurations having two 3p electrons excited from the arg type core to 3d states. Quantitatively, the parameters are too l by a factor of two when the interaction integrals are taken equal the exchange integrals of Watson's self-consistent field calculat The parameters are too small when the exchange integrals are evaluated from observed data in the $3p^53d$ configuration of Ca II

12250 POPULATION ENHANCEMENT IN MERCURY-KRYPTON GASEOUS DISCHARGES.
B.Senitzky, M.Newstein, N.Solimene and M.Schiff.
J. Opt. Soc. Amer., Vol. 51, No. 3, 367 (March, 1961).

The enhancement of the 9^1P_1 and $10^3P_1{}^o$ mercury levels at 79 964 cm^{-1} and 80 917 cm^{-1} by krypton was investigated using a r.f. discharge at different krypton pressures as a source and measurement of the relevant emission intensities at constant r. discharge power. The data are used to determine the relative population per quantum state using two methods. C.G.Mc

12251 MEASUREMENT OF THE TRANSITION PROBABILI OF THE O I MULTIPLET AT 6157 A.
W.L.Wiese and J.B.Shumaker, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 9, 937-42 (Sept., 1961).

A transition probability of $7.6 \times 10^6\ sec^{-1}$ for the $3p\ ^5P$-$4d\ ^5$ multiplet of O I at 6157 A was measured in a wall-stabilized, hi current arc operating in an atmosphere of oxygen containing a t of hydrogen. Electron densities were obtained from Hβ line-pr measurements, and upper-level populations were calculated as function of electron density by assuming local thermodynamic equilibrium. The method minimizes the turbulence and "demix problems associated with earlier measurements. Special atten was given to the accurate determination of the background of th spectral lines.

12252 ON THE OSCILLATOR STRENGTHS OF MULTIPLE OF NEUTRAL NITROGEN. J.Richter.
Z. Astrophys. (Germany), Vol. 51, No. 3, 177-86 (1961). In Ger

Measurements were made for 22 multiplets between 4300 a 11600 A. The results obtained for some line groups of N I show a systematic divergence from Motshcmann's measurements, but in good agreement with values calculated on the basis of the Coulomb approximation. R.A.Ne

1, 3 HYPERFINE STRUCTURE OF THE SPECTRA OF Pr I AND Pr II. K.Murakawa.
P . Soc. Japan, Vol. 15, No. 12, 2306-9 (Dec., 1960).
the spectrum of Pr I three lines were classified and the .s was measured, from which the interval factor of the level 6 $I_{11/2}$ was determined. From this and the known interval of $4f^3 6s^2\,{}^4I_{9/2}$, it was concluded that the value of a_{4f} deter- n from the h.f.s. of Pr II is also appropriate for Pr I. The nf uration $4f^3(^4I)6s$ of Pr II was treated as of intermediate ng, and the h.f.s. lead to a reasonable value of a_{4f} and a(6s). o the value of a(6s) the magnetic moment of Pr^{143} was calcul- pc be 4.0 ± 0.2 n.m.

54 A GENERAL SOLUTION OF THE STATISTICAL EQUILIBRIUM EQUATIONS. O.R.White.
hys. J. (USA), Vol. 134, No. 1, 85-90 (July, 1961).
is shown that those solutions of the statistical equilibrium u ons given by Giovanelli and Jefferies (1954) and Athay (1960) e rticular algebraic forms of a general solution given by s land (1926). It is then shown that the steady-state population t energy states of the general n-level atom is a function of the c ct of the mean lifetime (which describes the transitions out of e ate) and an algebraic cofactor (which describes the trans- c into the state). It is found that these cofactors can be inter- e i as the probability of transition between two states by all r edundant transition sequences. These transitions contain the ocking transitions which need to be considered in the general on. The frequency-independent source function for the jk ition in the general n-level atom is derived directly, and can itten in a general form which contains, as special cases, forms similar to those used by Thomas (1957), Thomas and Jefferies), Athay, (1960) Thomas and Athay (1961), Johnson (1960), and ries (1960). Furthermore, a specification of the linearized ency-independent source function with the cofactors taken as neters permits the source function to be written in essentially ame form for all lines of a given spectral series.

2255 DETERMINATION OF SPIN POLARIZATION FROM THE TRANSPARENCY VARIATIONS IN THE CASE OF ICAL PUMPING WITH THE NaD_1 LINE.
ersch, W.Raith and M.Rehmet.
ys. (Germany), Vol. 163, No. 2, 197-206 (1961). In German.
A Dehmelt-type experiment (Abstr. 9076 of 1958) was perform- sing Na vapour and argon as a buffer. The pumping radia- ur and argon as a buffer were employed. The pumping radia- consisted of the circularly polarized D_1 line. Since the strong- sorbing magnetic sublevels are depopulated, the vapour be- es more transparent for the pumping radiation with growing rization. The transparency of the vapour was measured with without optical pumping as a function of the sodium vapour sity. The degree of polarization was determined in simulating inc rease in transparency due to polarization by decreasing the ium vapour density of the unpumped sample. This method re- es a knowledge of the exact sodium vapour density in the perature range of interest (100 to 200°C). The determination he degree of polarization is based on the assumption that the nic absorption cross-section Q, which depends on the degree of rization P and the frequency of light ν, can be written in the n $Q(P, \nu) = A(P).B(\nu)$, where A(P) is a linear function of P, le $B(\nu)$ must not be changed by optical pumping. The degree of rization determined under these assumptions describes in good roximation the polarization of the sodium valence electrons.

2256 DETERMINATION OF THE HYPERFINE STRUCTURE OF ATOMIC NITROGEN BY CONTINUOUS OPTICAL ENTATION. W.W.Holloway, Jr and E.Lüscher.
vo Cimento (Italy), Vol. 18, No. 6, 1296-7 (Dec. 16, 1960).
The technique of atomic orientation by optical pumping with exchange was used to measure the hyperfine splitting constants tomic nitrogen. Caesium was used as the optical pumping agent air-cooled r.f. electrodeless discharges produced a continuous ply of N atoms. The zero field splitting for N^{14} was measured as $\nu(\frac{5}{2}-\frac{3}{2}) = 26\,127\,325 \pm 125$ Hz, $\nu(\frac{3}{2}-\frac{1}{2}) = 15\,676\,380 \pm 75$ Hz; and N^{15} as $\nu(2-1) = 29\,290\,950 \pm 100$ Hz. The hyperfine structure stants were measured as: N^{14} magnetic h.f.s. coupling constant 4)| = 10 450 928 ± 45 Hz, N^{14} quadrupole coupling constant 4)| = (5 ± 35) Hz; N^{15} magnetic h.f.s. constant |A(14)| = 645 475 ± 50 Hz. The hyperfine structure anomaly, due to cts of finite nuclear volume is $\Delta = (1.000 \pm 0.006) \times 10^{-3}$.
R.W.Nicholls

12257 OBSERVATION OF FORBIDDEN RESONANCES IN OPTICALLY DRIVEN SPIN SYSTEMS.
W.E.Bell and A.L.Bloom.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 623-4 (June 1, 1961).
A forbidden resonance of a type previously predicted (Abstr. 8821 of 1961) is reported. In it the magnetic sub-levels m = 1 and m = −1 of the metastable 2^3S state of helium, between which no direct coupling exists, are coupled to a common optically excited state. The g = 4 resonance was observed at 48 kc/s in a field of ~ 0.01 G. The signal amplitude depended on the square of the sine of the angle between the light axis and the field, as predicted from a brief theoretical treatment. The time-dependent alignment does not correspond to any directly observable macroscopic moment in this case. Resonance is independent of any displacement of the m = 0 level. J.Sheridan

12258 MAGNETIC RESONANCE OF ENERGY LEVELS OF Zn AND He^4 ATOMS EXCITED BY ELECTRON IMPACT.
B.Decomps, A.D.May and J.C.Pebay-Peyroula.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 138-42 (1960). In French.
9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The results of May (Abstr. 13880 of 1960) and Decomps et al. (Abstr. 2280 of 1961) are summarized. M.R.C.McDowell

IMAGINARY PART OF X-RAY SCATTERING FACTOR FOR GERMANIUM. See Abstr. 11559

12259 EFFECT OF INELASTIC SCATTERING ON POLARIZATION ASYMMETRY. G.Felsner and M.E.Rose.
Nuovo Cimento (Italy), Vol. 20, No. 3, 509-18 (May 1, 1961).
The inelastic scattering of polarized relativistic electrons by atoms is calculated in a modified first Born approximation. In order to evaluate the matrix elements the Thomas–Fermi model of the atom is used. The result shows that in the case of gold the asymmetry coming from the inelastic scattering makes a negligible change in the asymmetry to be attributed to the total, inelastic plus Mott, scattering.

12260 VARIATIONAL CALCULATION OF THE SCATTERING LENGTHS IN ELECTRON–HYDROGEN SCATTERING.
Y.Hara, T.Ohmura and T.Yamanouchi.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 467-74 (March, 1961).
The non-relativistic Schrödinger equation of electron plus hydrogen-atom system is solved by the Hulthén type variational method (1944) at the limit of zero incident-electron energy. Eight and five parameter trial functions are used for the singlet and triplet states respectively, and the following upper bounds on the scattering length a are obtained: $a_s \leq 6.217\ a_0$ (singlet), $a_t \leq 2.272\ a_0$ (triplet), where a_0 is the Bohr radius. The accuracy of the result is discussed.

12261 CALCULATION OF THE EXCHANGE ENERGY OF TWO SIMILAR, SINGLY NEGATIVELY CHARGED IONS WITH INERT GAS ELECTRON STRUCTURE IN THE FERMI–AMALDI MODEL. T.Tietz.
Ann. Phys. (Germany), Vol. 7, No. 7-8, 425-8 (1961). In German.
An approximate, relatively simple, analytic expression is devised. P.M.Parker

12262 ANTIFERROMAGNETIC LINEAR CHAIN. L.F.Mattheiss.
Phys. Rev. (USA), Vol. 123, No. 4, 1209-18 (Aug. 15, 1961).
Many-electron configuration interaction calculations were carried out on a system of six hydrogen atoms arranged in a regular hexagonal array with a variable lattice spacing. The approximate wave functions for this system were expressed as linear combinations of the $(2 \times 6)!/(6!)^2 = 924$ determinantal functions which can be formed from atomic 1s-functions. In this manner, the effects of ionic configurations containing as many as three pairs of doubly filled orbitals were introduced into the calculations. All three- and four-centre integrals were taken into account. The non-orthogonality of hydrogenic 1s-orbitals localized about different atomic sites were removed by transforming to a set of orthonormal Wannier functions. The principal result of these calculations is the fact that the effects of configuration interaction can be represented quite accurately at large internuclear separations in terms of a parameter J' (analogous to a nearest-neighbour exchange integral) which assumes a negative value in a non-ferromagnetic system such as this one. This provides a justification for the use of the Heisenberg exchange operator, $-J'[2s_i s_i \cdot s_{i+1} - (\frac{1}{4})]$, to describe the magnetic interaction at large separations in this system. In addition, these

results show that this system of hydrogen atoms is bound with respect to six separated atoms, but not with respect to three molecules. The ground-state wave function is a singlet at all internuclear separations. The general form of the curves representing energy as a function of internuclear separation show a striking similarity to those obtained for the hydrogen molecule.

12263 EFFECTIVE EXCHANGE INTEGRAL.
L.F.Mattheiss.
Phys. Rev. (USA), Vol. 123, No. 4, 1219-25 (Aug. 15, 1961).

The magnetic properties of a linear chain of monovalent atoms are investigated from the point of view of perturbation theory. The many-electron wave-functions for the system are expanded as linear combinations of determinantal functions which are eigenfunctions of S^2 and S_z. These determinantal functions are constructed from orthonormal one-electron orbitals of the Wannier type so that the nearest-neighbour exchange integral is positive definite and approaches zero at large lattice spacings. The secular equation is set up using the method of the Dirac vector model. By means of the Kramers perturbation technique, the interaction of ionic states with those arising from the ground configuration is represented by means of an effective Hamiltonian operator with its associated matrix. The results of this treatment are analogous to those obtained by Paul in that an analytic expression is found for an effective nearest-neighbour exchange integral J'. This quantity is represented as the difference between the positive definite exchange integral and additional terms from ionic states. The present treatment defines in a fairly precise manner the type configurations which contribute to this effective exchange integral and the limits for which this parametrization is valid. The results of this analysis with those obtained from recent calculations on a system of six hydrogen atoms.

12264 THEORY OF LONG-RANGE INTERATOMIC FORCES. I. DISPERSION ENERGIES BETWEEN UNEXCITED ATOMS. P.R.Fontana.
Phys. Rev. (USA), Vol. 123, No. 5, 1865-70 (Sept. 1, 1961).

A general theory of second-order dispersion forces between atoms in nondegenerate ground states is developed by using an irreducible tensor formalism and the theory of angular momentum. This forms the basis for calculations of forces between excited systems. Attention is given to the interaction of two noble gas atoms where it is assumed that each electron oscillates with simple harmonic motion, and the interaction between two alkali atoms is calculated by considering the electrons to be moving in a Coulomb field. The dominant terms of the dispersion energy between a number of atoms and molecules are tabulated. The results indicate that the hitherto neglected dipole—octupole contributions are in many cases larger than the quadrupole—quadrupole terms.

12265 THEORY OF LONG-RANGE INTERATOMIC FORCES. II. FIRST-ORDER INTERACTION ENERGIES IN THE UNCOUPLED REPRESENTATION. P.R.Fontana.
Phys. Rev. (USA), Vol. 123, No. 5, 1871-81 (Sept. 1, 1961).

General methods are developed to calculate the matrix elements between two arbitary states and for any multipole order. The results are expressed in terms of generalized hypergeometric functions. Some delta conditions in the formula for the electrostatic potential allow substantial factorization of the secular determinant. A device called the interaction diagram is introduced to facilitate the ordering of the secular determinant and the classification of the resulting molecular states. The theory is first applied to systems in which spin—orbit effects are neglected. The energy curves between an alkali atom in the ground state and an alkali atom in the first and second excited states, two alkali atoms in the first excited state, and an alkali atom in the first and another in the second excited state are calculated. In the last case, where some matrix elements consist of more than one multipole term, the competition of multipoles leads to energy curves which have maxima and minima in first order. It is also shown that for the interaction between atoms in excited states the resonance forces are less dominant while configuration interactions and the forces obtained from simple product state functions become more and more important.

12266 ADJUSTMENT OF RELATIVE NUCLIDIC MASSES. I. $A \leq 70$.
F.Everling, L.A.König, J.H.E.Mattauch and A.H.Wapstra.
Nuclear Phys. (Internat), Vol. 25, No. 2, 177-215 (May, 1961).

An outline is given of the general procedure used in the least-squares computation of masses from all relevant measurements. The data available for the mass range $1 \leq A \leq 70$ are tabulated and discussed.

Isotopes

12267 SEPARATION OF THE ISOTOPES HT AND ORTHO- BY ADSORPTION AT LOW TEMPERATURES.
A.Katorski, J.G.Eberhart and D.White.
J. chem. Phys. (USA), Vol. 34, No. 6, 2189-90 (June, 1961).

A theory developed to account for the separation of heteronuclear isotopic diatomic species is applied to predict the separation of HT and ortho-D_2. G.I.W.Llew

12268 SEPARATION FACTORS IN MULTICOMPONENT MIXTURES OF ISOTOPES. A.Narten.
J. chem. Phys. (USA), Vol. 34, No. 6, 2198-9 (June, 1961).

The conclusion is reached that for such mixtures and where rule of the mean holds the effective separation factor, α, will b concentration independent (if Raoult's law is obeyed); in cases w the rule does not hold α will be concentration dependent. A dis cussion is given of the system of isotopic nitric oxides at 121°K of isotopic water molecules at 373°K. W.

Mesic Atoms

12269 X-RAY DEFICIENCY IN MESONIC ATOMS.
Y.Eisenberg and D.Kessler.
Phys. Rev. (USA), Vol. 123, No. 4, 1472-7 (Aug. 15, 1961).

Presents an analysis of π-mesonic atoms, based upon casc calculations taking into account the known processes of radiatio Auger transitions, and nuclear absorption. This analysis, toget with the previous one on μ-mesonic atoms, is intended to provic a deeper insight into the unsolved problem of the deficiency of X-rays in mesonic atoms. It is shown that the π-mesonic L X-r yields (for $Z \leq 20$) are quite insensitive to the strength of nucle absorption and depend only upon the chosen initial meson popula of the higher levels. Similarly, the ratios of basic (K_α, L_α, etc to higher X-ray yields, both for μ and π-mesons, depend strong on the initial distribution. The best agreement between the calc lations and experiment was obtained for a "modified statistical" initial population of the form $(2l + 1)e^{al}$, with $a = 0.2$, in the $n =$ level. From the existing experimental data on π-mesonic K X-r the mean life of the π-meson in nuclear matter was deduced: $\tau_c = 2.75 \times 10^{-23}$ sec. Within the framework of the present the it is still impossible to account for the X-ray deficiency in the l atoms. However, it is shown that the quantum loss as a functio of energy is different for π- and μ-mesonic atoms, and therefo it is very probably due to a real physical effect. Furthermore, comparing the predicted Auger electron yields with the experimental data, one can rule out any hypothetical simple Auger pro in which the full energy of the "missing" quantum is given to a single electron.

12270 NUCLEAR POLARIZATION IN MESIC ATOMS OF TRITIUM, He^3 AND He^4. C.Joachain.
Nuclear Phys. (Internat.), Vol. 25, No. 2, 317-27 (May, 1961).

The energy-shift due to polarization of the H^3, He^3 and He^4 nuclei by a bound μ-meson was evaluated. This effect is smalle than the energy-shift caused by the finite extension of the nucle There is no compensation as in the deuteron case.

MOLECULES

12271 GENERAL RELATION BETWEEN POTENTIAL EN AND INTERNUCLEAR DISTANCE FOR DIATOMIC MOLECULES. III. EXCITED STATES.
E.R.Lippincott, D.Steele and P.Caldwell.
J. chem. Phys. (USA), Vol. 35, No. 1, 123-41 (July, 1961).

A previously proposed internuclear potential function (Abst 7231 of 1955) is used to calculate the dissociation energies for excited states of a large number of diatomic molecules. From these results and the Wigner—Witmer rules the dissociation pr are determined, and it is shown that in many cases it is possibl estimate independently, the dissociation energy of the ground st The three- and five-parameter forms of the proposed function l to nearly equal values for dissociation energies suggesting an equivalence of the two forms. This leads to a relation between anharmonicity and the vibrational-rotational coupling constant

htly superior to the Pekeris relation. Equations derived from lation are given relating the parameters a and b of the five- eter functions to the anharmonicity or vibrational-rotational ng constant. The parameter b and to a lesser extend a was nearly constant for the excited states of all diatomic molecules.

72 NEW POTENTIAL FUNCTION FOR ALKALI HALIDE MOLECULES. Y.P.Varshni and R.C.Shukla.
m. Phys. (USA), Vol. 35, No. 2, 582-7 (Aug., 1961).
new potential-energy function is suggested for the alkali molecules,

$$U = (-e^2/r) + P\exp(-kr^2),$$

P and k are constants. Values of α_e, $\omega_e x_e$, and the ionic g energy D_1 are derived for the following three functions: nple Born–Mayer potential, (2) Rittner potential, and (3) the suggested potential. The results obtained with the new on are much better than those obtained with the Born–Mayer tial, but slightly inferior to those obtained with the Ritter tial.

273 ANHARMONIC POTENTIAL CONSTANTS AND THEIR DEPENDENCE UPON BOND LENGTH.
lerschbach and V.W.Laurie.
em. Phys. (USA), Vol. 35, No. 2, 458-63 (Aug., 1961).
Empirical study of cubic and quartic vibrational force constants iatomic molecules shows them to be approximately exponential ions of internuclear distance. A family of curves is obtained, mined by the location of the bonded atoms in rows of the dic table. Displacements between sucessive curves correspond ly to those in Badger's rule for quadratic force constants (for the parameters are redetermined to accord with all data now able). Constants for excited electronic and ionic states appear actically the same curves as those for the ground states. ictions based on the diatomic correlations agree with the able cubic constants for bond stretching in polyatomic mole-, regardless of the type of bonding involved. Some implications ese regularities are discussed.

2274 DEPENDENCE OF VIBRATIONAL RELAXATION TIME ON THE VIBRATIONAL QUANTUM NUMBER. EXPERIMENTAL VERIFICATION FOR NO ($A^2\Sigma^+$) BEHIND SHOCK WAVES.
oth.
hem. Phys. (USA), Vol. 34, No. 6, 2204-5 (June, 1961).
Briefly discusses the theoretical dependence of collision-ced vibrational transition probability on vibrational quantum ber using the model of a non-rotating harmonic oscillator. erimental observations of the temporal behaviour of $\gamma(2,7)$ and 6) bands of the $A\ ^2\Sigma^+$ state of NO are compared with the $\gamma(1,1)$ $\gamma(0,0)$ bands studied in an earlier paper (Abstr. 5997 of 1961) good agreement with theory is obtained. M.McChesney

12275 ATOMIC POLARIZATION. III. VIBRATIONAL POLARIZATION TERMS ASSOCIATED WITH FORBIDDEN TRANSITIONS IN POLYATOMIC MOLECULES.
H.Illinger and C.P.Smyth.
chem. Phys. (USA), Vol. 35, No. 2, 397-400 (Aug., 1961).
For Pt II, see Abstr. 11754 of 1961. The contribution, to the al vibrational polarization, of transitions forbidden by harmonic illator selection rules is examined for the case of polyatomic lecules in the gaseous state. Numerical calculations are given a number of molecules. In connection with these results, teria are developed for the completeness of the treatment, de-oped in previous parts in this series, taking into account the harmonicity of the vibrations but limiting the contributions to se associated with transitions allowed by harmonic oscillator ection rules. The present work permits one to draw conclusions to the applicability of this approximation to a given polyatomic lecule.

2276 ATOMIC POLARIZATION. IV. TEMPERATURE DEPENDENCE OF THE VIBRATIONAL POLARIZATION GASES. K.H.Illinger and C.P.Smyth.
hem. Phys. (USA), Vol. 35, No. 2, 400-9 (Aug., 1961).
A treatment of the temperature dependence of the vibrational rization of gases is given in several degrees of approximation. culations are presented for a number of molecules.

12277 ATOMIC POLARIZATION. V. NORMAL MODE POLARIZABILITY AND THE ADDITIVITY OF THE RATIONAL POLARIZATION. K.H.Illinger.
hem. Phys. (USA), Vol. 35, No. 2, 409-19 (Aug., 1961).
The vibrational polarizability of a molecule is derived in eral degrees of approximation and is calculated for a number of molecules. An extension of this treatment is then presented, terminating in the development of the properties of the normal mode polarizability. The criteria for the additivity of the vibrational polarization of a molecule in terms of the normal mode polarizabilities of its constituent segments are developed. Numerical calculations of the normal mode polarizability terms are given for a large number of molecules.

12278 VIBRATION PERTURBATIONS IN ELECTRONICALLY EXCITED MONOSUBSTITUTED BENZENES.
O.E.Weigang, Jr and A.J.Dahl.
J. chem. Phys. (USA), Vol. 34, No. 5, 1845-6 (May, 1961).
Studies on the effects of solvents on electronically excited molecules are described and discussed in terms of bond shortening due to solvent–solute interactions. W.J.Orville-Thomas

12279 NORMAL VIBRATIONS AND RAMAN SPECTRUM OF POLYOXYMETHYLENE.
H.Tadokoro, A.Kobayashi, Y.Kawaguchi, S.Sobajima, S.Murahashi and Y.Matsui.
J. chem. Phys. (USA), Vol. 35, No. 1, 369-70 (July, 1961).
Urey–Bradley calculations, omitting torsional coordinates, were made of the A_1, A_2 and E_1 vibrations. Fairly good agreement with observed infrared and Raman frequencies is obtained, and the assignments are supported by observations on dichroism, intensity and on the spectrum of the deuterated polymer. R.F.Barrow

12280 MULTIPLE VIBRATIONAL RELAXATION IN GASEOUS DIBROMOMETHANE. P.G.Dickens and D.Schofield.
J. chem. Phys. (USA), Vol. 35, No. 1, 374-5 (July, 1961).
Theoretical analysis of experiments reported by Meyer (Abstr. 14695 of 1960) suggests that his assignments of the vibrational modes to the separate dispersion regions are not correct; application of the calculation methods of Abstr. 8895 of 1956 seems to show a fundamental disagreement between theory and experiment as regards the dispersion curve. J.Hawgood

12281 MAGNETIC HYPERFINE STRUCTURE IN THE ROTATIONAL SPECTRUM OF H_2CO. H.Takuma.
J. Phys. Soc. Japan, Vol. 16, No. 2, 309-17 (Feb., 1961).
The theory of magnetic hyperfine interaction of an asymmetric rotor molecule with C_{2v} symmetry in the $^1\Sigma$ state was discussed, and the magnetic hyperfine structures in the low frequency rotational spectrum of formaldehyde were studied with a beam maser. The $\Delta F = 0$ and the $\Delta F = \pm 1$ components in the $J = 4$, $K_{-1} = 3$ and $J = 5$, $K_{-1} = 3$ Q-branch transitions were observed with good signal-to-noise ratio. The frequency of the $\Delta F = 0$ component of the $J = 5$, $K_{-1} = 3$ line was measured as 18.275 ± 0.004 Mc/s. The observed hyperfine structures were analysed with the theory, and the hyperfine coupling constants were determined as $\alpha = -13.2 \pm 3.4$ kc/s, $\beta = -3.0 \pm 3.4$ kc/s, and $\gamma = 30.2 \pm 2.7$ kc/s. The coupling constants were theoretically interpreted, and a proportionality of the hyperfine coupling constants and the rotational g factors for the asymmetric rotor molecule was found. $\langle r^{-3}_{electron}\rangle_{av}$ around the proton in H_2CO was obtained as 1.5×10^{24} cm^{-3} from the comparison of these two quantities.

12282 THE σ-STARK EFFECT OF ROTATIONAL TRANSITIONS. I. EXPERIMENTAL ASPECTS.
A.Dymanus and H.A.Dijkerman.
Physica (Netherlands), Vol. 27, No. 6, 593-602 (June, 1961).
A method is described for the automatic recording of the Stark-splitting patterns of microwave transitions corresponding to $\Delta M = \pm 1$. Potentialities and limitations of the method are shown in the application to the $J = 1 \rightarrow 2$ rotational transition of the $O^{16}C^{12}S^{32}$ molecule in the ground and in the excited bending (1-doublet) vibrational state. Generally, splitting patterns could be recorded over frequency intervals up to 400 Mc/s. Slight distortion of the line shapes and of the relative intensities could not be avoided, however.

12283 MICROWAVE SPECTRUM, DIPOLE MOMENT, STRUCTURE, AND INTERNAL ROTATION OF DIMETHYL SULFIDE. L.Pierce and M.Hayashi.
J. chem. Phys. (USA), Vol. 35, No. 2, 479-85 (Aug., 1961).
The microwave spectra of five isotopic species of dimethyl sulphide are reported. Changes in rotational constants with isotopic substitution yield the following structural parameters: CS 1.802 A; CSC = 98°52'; CH 1.901 A; HCH = 109°34'; $2\theta = 104°22'$, where 2θ is the angle between the symmetry axes of the methyl groups. The equilibrium conformation of both methyl groups is the staggered one, i.e., staggered with respect to the adjacent CS bond axis. From

Stark effect measurements the dipole moment of dimethyl sulphide is found to be 1.50 ± 0.01 debye. Fine structure in the ground-state rotational spectrum of $(CH_3)_2S$ and an excited torsional state of CH_3SCD_3 has been resolved and analysed. This fine structure results from coupling of internal and over-all rotation and is affected by top-top coupling terms in the kinetic and potential energy portions of the Hamiltonian. Neglecting only the potential energy coupling terms, the $(CH_3)_2S$ and CH_3SCD_3 splittings yield as the barrier to internal rotation 2132 ± 6 and 2118 ± 3 cal/mole, respectively. Estimates of the potential energy coupling parameters are made. They are found to be an order of magnitude smaller than the main term of ~ 2100 cal/mole in the Fourier expansion of the potential energy.

12284 RECENT STUDIES OF THE STRUCTURE OF SOME SIMPLE MOLECULES BY MICROWAVE SPECTROSCOPY.

J.Sheridan, A.P.Cox, J.K.Tyler, L.F.Thomas and A.C.Turner.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 135-6 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). An outline is given of microwave structural measurements on various isotopic forms of fluorine cyanide, fluoroacetylene, chloroacetylene, diazomethane, cyanamide and silyl cyanide. Some features of the structures found are indicated. J.Sheridan

12285 MICROWAVE SPECTRUM OF FORMALDEHYDE. I. K-TYPE DOUBLING SPECTRA.

T.Oka, H.Hirakawa and K.Shimoda.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2265-73 (Dec., 1960).

Microwave spectral lines for the direct transitions between the K-type doublets were measured from 3 kMc to 40 kMc for H_2CO and for its isotopically substituted molecules HDCO, $H_2C^{13}O$ and H_2CO^{18}. The observed spectra and the previously reported data for H_2CO were analysed by a digital computer by the use of Kivelson and Wilson's method for the centrifugal distortion correction. The asymmetry parameter b and B−C were obtained for each isotopic species as follows:

	B−C (Mc/s)	b
H_2CO	4832.13 ± 0.01	−0.0098370 ± 0.0000010
$H_2C^{13}O$	4595.47 ± 0.02	−0.0093205 ± 0.0000010
H_2CO^{18}	4391.08 ± 0.02	.....
HDCO	5347.77 ± 0.04	−0.0161170 ± 0.0000020
D_2CO	6097.35 ± 0.02	−0.0271170 ±0.0000020

It was found that the observed frequencies fit well to those calculated from the centrifugal distortion constants which were derived by the vibration–rotation interaction theory.

12286 MICROWAVE SPECTRUM OF FORMALDEHYDE. II. MOLECULAR STRUCTURE IN THE GROUND STATE.

T.Oka.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2274-9 (Dec., 1960).

Rotational constants for the isotopic formaldehyde molecules H_2CO, $H_2C^{13}O$, H_2CO^{18}, HDCO and D_2CO were determined from the parameters used in the analysis of K-type doubling spectra and the frequencies of $1_{01} - 0_{00}$ transitions. In the cases of isotopic species for which the R-branch transitions were not measured, the calculated inertia defect was used in the determination of the rotational constants. From the rotational constants, the zero-point structure of the formaldehyde molecule, r_z, was determined by a new method taking into account the zero-point vibration–rotation interaction and electronic interaction. The following zero-point molecular structure was obtained:

$$r_{C-H} = 1.117_4 \pm 0.002 \text{ A}$$
$$\angle HCO = 122^\circ 5' \pm 20'$$
$$r_{C=O} = 1.206_3 \pm 0.002 \text{ A} \quad \text{planar.}$$

All of the rotational constants calculated from these geometrical parameters fit to the observed values within the experimental error. In contrast to the previous researches, ∠HCO is much larger than 120°. It was also confirmed that the formaldehyde molecule is completely planar in the ground vibrational state.

12287 MICROWAVE SPECTRUM OF O^{18} FORMYL FLUORIDE AND THE STRUCTURE OF FORMYL FLUORIDE.

R.F.Miller and R.F.Curl, Jr.
J. chem. Phys. (USA), Vol. 34, No. 5, 1847-8 (May, 1961).

Rotational constants A, B and C were determined from seven transitions of $HCO^{18}F$. Three transitions of $HC^{13}OF$ were assigned with a revised A-value for this form. From the new data, and the of LeBlanc, Laurie and Gwinn (Abstr. 15738 of 1960) for other topic species, bond distances were computed with stated uncer ties of less than 0.01 A. The angle FCO is 122°46' ± 30', but ag involving the CH bond are uncertain by ±3°. Limitations set b proximity of the C and H atoms to the b-axis are discussed. structure agrees with electron diffraction data [Jones et al. J. Amer. Chem. Soc., Vol. 77, 5278 (1955)]. J.Sh

12288 INFLUENCE OF TEMPERATURE ON THE STRUC OF THE VIBRATIONAL BANDS OF KETONIC CARBONYL GROUPS AND OF THE BENZENE RING. C.Man

J. Phys. Radium (France), Vol. 21, No. 2, 143-4 (Feb., 1960). In French.

The 1700 cm^{-1} band of the C = O group and 1600 cm^{-1} ban the benzene ring are considered. From the molecules investig it is seen that a rise in temperature causes the fundamental vi tionafrequency of the C = C bond to diminish. This variation i the opposite direction to that observed for the vibration of the bonyl group. For aromatic ketones, the two effects are relate to the migration of the π-electrons in these systems. T.E.Pe

12289 TEMPERATURE DEPENDENCE OF INFRARED ABSORPTION BANDS OF N-HIGHER ALCOHOLS.

M.Hasikuni.
J. Phys. Soc. Japan, Vol. 15, No. 5, 941-2 (May, 1960).

Spectra of three alcohols, $C_{18}H_{37}OH$, $C_{16}H_{33}OH$ and $C_{14}H_{29}O$ in the liquid, α and β states, over the range 700-1500 cm^{-1}, ex three main groups of bands. The intensity of these bands, whi characterized by their uniform spacing and relative intensity, examined as a function of temperature. D.L.Gree

INFRARED SPECTRA OF SOME GROUP IV HALIDES.
See Abstr.11790

12290 COMPREHENSIVE INVESTIGATION OF THE ELECTRONIC SPECTROSCOPY AND THEORETIC TREATMENTS OF FERROCENE AND NICKELOCENE.

D.R.Scott and R.S.Becker.
J. chem. Phys. (USA), Vol. 35, No. 2, 516-31 (Aug., 1961).

New data concerning the electronic absorption and emissio spectra of ferrocene and the absorption spectrum of nickelocen presented. Assignment and discussion of the transitions are m based on the experimental results. No ferrocene emission is observed upon excitation into the lowest energy absorption ban emission occurs upon excitation into the next higher energy ba These results are interpreted in terms of crossing of the first excited state and the ground state. The luminescence is long li and is interpreted as phosphorescence paralleling an assigned singlet-triplet absorption at 5280 A. No nickelocene emission noted. Assignments of the absorption bands of ferrocene and nickelocene are proposed within the framework of each of the t theoretical approaches.

12291 THE CONNECTION BETWEEN THE ABSORPTION COEFFICIENTS AND INTENSITY OF THE RAMAN LINES IN THE RESONANCE REGION.

I.I.Kondilenko and P.A.Korotkov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 765-72 (1958). In Ukrai

Presents the results of an experimental study of the depen of Raman line intensity of a n-nitroaniline solution in benzol an of $NaNO_2$ in water on the frequency of the exciting light in the region of the first electron absorption band. The change in the absorption coefficient and the intensity of the observed lines, depending on the frequency of the exciting light, was investigate The frequencies of the 1335 cm^{-1} vibrations of the NO_2^- group w studied in both cases. A Raman spectrum was obtained with relatively short exposures not only at maximum absorption, bu in the shorter wavelength region. In the case of a n-nitroanilin solution in benzol, the electron absorption band in the nearer p of the ultraviolet proved to be only partly actual for vibrations the NO_2^- group with a frequency of 1335 cm^{-1}. The intensity of Raman line kept on increasing beyond the maximum absorption The intensity of this line in the case of an aqueous $NaNO_2$ solut follows in the resonance region (before the absorption maximu the change in the absorption coefficient, which is evidence of th actuality of the maximum absorption (λ max = 355 mμ) for whic the NO_2^- ion is responsible.

12292 EXCITATION TRANSFER SPLITTING IN THE n→π* TRANSITIONS OF THE DIAZINES.
.-Sayed and G.W.Robinson.
n. Phys. (USA), Vol. 34, No. 5, 1840-2 (May, 1961).
ie n→π* electronic spectra of the diazines trapped in crystal-
., Ne, Ar, Kr and Xe at 4.2°K were measured. An analysis
vibronic structure of the 3200 A transition of pyrazine shows
itting to be of the order of 435 ± 15 cm^{-1}, and for the
sponding bands in pyrimidine and pyridazine −840 ±100 cm^{-1}
30 ± 100 cm^{-1} respectively. These splittings are calculated
an "independent systems" model in which the excited π*
t is considered to be localized on the nitrogen atom. The
obtained are: pyrazine 440 cm^{-1}, pyrimidine 900 cm^{-1} and
zine 9030 cm^{-1}. These values are in excellent agreement with
perimental values. T.E.Peacock

12293 DETERMINATION OF THE MOLECULAR PROPERTIES OF $Tl^{205}F^{19}$ FROM COMBINED STARK–ZEEMAN CT MEASUREMENTS USING THE MOLECULAR BEAM IOD. W.Drechsler and G.Gräff.
ys. (Germany), Vol. 163, No. 2, 165-96 (1961). In German.
n electric molecular-beam-resonance-spectrometer was used
asure simultaneously the Zeeman and Stark effect splitting of
perfine structure of TlF. Electric fourpole lenses served as
ing and refocusing fields of the spectrometer. A homogeneous
etic field (Zeeman field) was superimposed on the electric
(Stark field) in the transition region of the apparatus. The
ved $\Delta m_J = \pm 1$-transitions were induced electrically.
letely resolved spectra of $Tl^{205}F^{19}$ in the J = 1 rotational, and
vibrational state were measured. The quantities obtained were
otational magnetic moment μ_J of $Tl^{205}F^{19}$ in the state J = 1,
, and the difference of the magnetic shielding $(\sigma_{1,\pm 1} - \sigma_{1,0})$ of
nuclei as well as the difference of the molecular susceptibility
$_{,\pm 1} - \xi_{1,0})$ in the states $(J, m_J) = (1, \pm 1)$ and $(J, m_J) = (1, 0)$.
sign of the rotational magnetic moment could be determined
nbiguously by the influence of off-diagonal matrix elements. The
erical values for $Tl^{205}F^{19}$ in the state J = 1 and v = 0 are:
$- 29.153(21) \times 10^{-6}$ μ_{Bohr}; $(\sigma_{1,\pm 1} - \sigma_{1,0})^{Tl} = - 0.002291$ (33);
$_{\pm 1} - \sigma_{1,0})^{F} = - 0.000\,206(9)$; $(\xi_{1,\pm 1} - \xi_{1,0}) = + 3.02(15) \times$
$^{-30}$ erg/gauss^2. The quantities in brackets are root-mean-
re deviations in units of the last digit. From these data and the
n values for the spin–rotational interaction constants a num-
of expressions are derived which characterize the electronic
ge distribution in the molecule.

12294 OPEN-SHELL WAVE FUNCTIONS FOR CONJUGATED HYDROCARBONS. J.R.Hoyland and L.Goodman.
em. Phys. (USA), Vol. 134, No. 4, 1446-7 (April, 1961).
Roothaan's theory for open-shell configurations (Abstr. 17807
960) is applied to the positive and negative ions of naphthalene.
MO's of these open-shell species differ significantly from those
ie ground state. However, these results together with those for
en other molecules (not given here) lead to the conclusion that
n-shell configuration wave-functions constructed from ground
e MO's are a reasonable approximation to the true wave-
tions. Reminimization of the open-shell state becomes import-
when the charge distribution is considered. T.E.Peacock

12295 STUDY OF THE BIFLUORIDE ION FHF^- BY WAVE MECHANICS. G.Bessis.
iers de Phys. (France), Vol. 15, 105-39 (March, 1961).
French.
Describes a study of the hydrogen bond by means of a simplified
figuration interaction calculation on FHF^-, the approximations
de being tested by making a control calculation on FH which
eed well with that of Karo and Allen (Abstr. 1511 of 1960). It is
nd that the ion has a stable ground state but no stable excited
tes, and that the charge distribution is consistent with the electro-
tic model of the H bond. J.Hawgood

12296 DEPOLARIZATION OF SCATTERED LIGHT BY n-PARAFFIN VAPORS AND THE ADDITVITY OF BOND LARIZATION TENSORS. J.Powers, D.A.Keedy and R.S.Stein.
chem. Phys. (USA), Vol. 135, No. 1, 376-7 (July, 1961).
In order to investigate internal field effects on bond polari-
ilities, a careful measurement of the depolarization of the
ttering of a series of n-paraffins up to heptane was undertaken.
e results are interpreted to show the presence of two effects: (1)
ecreasing influence of the terminal methyl group with increasing
in length, and (2) an increasing distortion of the external field
the internal field as the chain length is increased.
T.E.Peacock

12297 FARADAY EFFECT IN MOLECULES.
I.Tobias and W.Kauzmann.
J. chem. Phys. (USA), Vol. 35, No. 2, 538-43 (Aug., 1961).
The relationship between the measured Verdet constants of a number of molecules and the quantum-mechanical theory of the Faraday effect is examined. The observed behaviour of nitric oxide, which is significantly different from that of the diamagnetic gases, is explained by a consideration of the effect on the Verdet constant of the transition from the $^2\Pi_{\frac{1}{2}}$ state to the $^2\Sigma$ state lying at 44 000 cm^{-1}.

12298 d-HYBRIDIZATION OF THE Pi BOND IN THE $2p\pi_u$ STATE OF H_2^+. O.Sovers and W.Kauzmann.
J. chem. Phys. (USA), Vol. 35, No. 2, 652-5 (Aug., 1961).
LCAO-MO calculations are made for the $2p\pi_u$ state of H_2^+. Trial wave-functions are constructed which involve dπ orbitals as well as pπ orbitals about the two nuclei, and the energy is computed for internuclear distances between 2 and 10 a.u. The discrepancies between these energies and the exact energies are decreased by as much as 87% as compared with the discrepancies obtained on using p orbitals alone. Inclusion of d orbitals also results in a considerable improvement in the equilibrium internuclear distance. The maximum ratio of the coefficients of the d orbitals to those of the p orbitals is about 0.24. The approximate wave-functions are also compared graphically with the exact solution.

12299 PARAMETERIZATION OF ORTHOGONALITY AND NORMALIZATION CONDITIONS FOR THE NbF_7^{-2} STRUCTURE. R.L.Wilson and G.H.Duffey.
J. chem. Phys. (USA), Vol. 35, No. 2, 568-70 (Aug., 1961).
General spd hybrid orbitals of C_{2v} symmetry were set up for the distorted trigonal prism NbF_7^{-2} structure. The orthogonality and normalization conditions were introduced and expressed in parametric form. On varying the parameters, the authors found the greatest Pauling strength, averaging 2.987, when the composition was $s^{0.89}p^{2.49}d^{3.62}$.

12300 STUDIES IN MOLECULAR STRUCTURE. V. COMPUTED SPECTROSCOPIC CONSTANTS FOR SELECTED DIATOMIC MOLECULES OF THE FIRST ROW.
S.Fraga and B.J.Ransil.
J. chem. Phys. (USA), Vol. 35, No. 2, 669-78 (Aug., 1961).
For Pt IV see Abstr. 10110 of 1961. Limited LCAO MO functions are computed for several diatomic molecules at four different values of the internuclear distance near R_e, and the corresponding total energies fitted to a third degree polynomial in R. Spectroscopic constants ω_e, $\omega_e x_e$, B_e, α_e, R_e, k_e are derived from the resulting potential curve and compared to observed values. The good agreement obtained in most cases suggests a valuable application of the self-consistent field function. In addition calculations are made for a few more values of the internuclear distance providing a potential curve over a reasonably broad range around R_e.

12301 THEORY OF PROTON MAGNETIC SHIELDING.
M.Fixman.
J. chem. Phys. (USA), Vol. 35, No. 2, 679-88 (Aug., 1961).
If an unsymmetrized product of molecular orbitals is used to represent the ground state of a molecule, the proton magnetic shielding is the sum of contributions from each molecular orbital. In the simplest variation theory of the perturbation of these orbitals by the proton magnetic dipole and an external magnetic field, the perturbation vanishes if the vector potential representing the external field is caused to vanish at the charge centroid of the orbital. Proton magnetic shielding constants are evaluated on this basis with molecular orbitals of the form $\Psi(1) = [(1-\gamma)\Psi_a^2(1) + \gamma\Psi_b^2(1)]^{1/2}$. This form was first examined by an energy variation on H_2, the energy being minimized with respect to internuclear distance and a screening constant, and was then applied to proton magnetic shielding in H_2. In subsequent calculations γ was evaluated from electric dipole moments when possible. Proton magnetic shielding constants were then evaluated for the C–H bond (methane, ethylene, and acetylene), the Group VI hydrides (H_2O, H_2S, H_2Se), and the hydrogen halides (HF, HCl, HBr, HI).

12302 ON THE INTRODUCTION OF ARBITRARY ANGULAR PEAKEDNESS INTO ATOMIC ORBITALS.
O.G.Ludwig and R.G.Parr.
J. chem. Phys. (USA), Vol. 35, No. 2, 754-5 (Aug., 1961).
It is found that the use of a single angular term of the form $\cos^n\theta$, where n is a variational parameter, greatly improves one-centre wave-functions for H_2 and H_2^+. See also Abstr. 2017 of 1958, in which some minor numerical errors are here corrected.
J.Hawgood

12303 EVALUATION OF MOLECULAR INTEGRALS BY A NUMERICAL METHOD. E.A.Magnusson and C.Zauli.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 53-64 (July, 1961).

Numerical integration in elliptical coordinates is proposed as a convenient method for the computation of most types of two-electron molecular integrals including some types of three- and four-centre integrals, and in some cases, of one-electron two- and three-centre integrals. This method removes a great deal of the burden of analysis and in addition lifts many of the restrictions on the form of the orbitals which are imposed by existing methods. For Slater-type orbitals general formulae are given to facilitate the calculation of two-centre Coulomb integrals, hybrid repulsion integrals and certain three-centre integrals. Explicit expressions are listed for integrals involving orbitals of the first, second and third quantum shell.

12304 THE POLARITY OF THE DIATOMIC MOLECULE. K.O-ohata.
Progr. theor. Phys. (Japan), Vol. 25, No. 7, 215-28 (Feb., 1961).

The relation between the ionicity of the bond and the electronegativity difference is discussed by the use of the semi-localized orbital method. It is found that the ionicity of the bond depends not only on the electronegativity difference but also on the overlap integral between the atomic valence orbitals. According to the magnitude of the overlap integral, diatomic molecules are divided into two groups which show different features with respect to the dependence of the ionicity of the bond on the electronegativity difference. The S-shaped curve given by Townes and Dailey (Abstr. 2959 of 1955) from an analysis of the results of the measurements of eQq seems to be the composite of the above two characteristic groups.

12305 DIELECTRIC PROPERTIES OF POLYAMIDES. A.J.Curtis.
J. chem. Phys. (USA), Vol. 34, No. 5, 1849-50 (May, 1961).

Dielectric relaxation measurements are reported over the frequency range 50 c/s to 10 Mc/s at temperatures from -100° to +175°C on poly(hexamethylene adipamide) - Nylon 66 - and poly(hexamethylene sebacamide)- Nylon 610. Four phenomena are identified: above 80°C a dipolar relaxation, sensitive to thermal history; an ionic process at very low frequencies above 60°C; a room temperature process at 10 kc/s (the β-peak found in mechanical measurements) and a low temperature peak corresponding to the mechanical γ-peak, which has not been previously reported.
R.G.C.Arridge

12306 ELECTRON SPIN RESONANCE STUDIES OF SOME QUINONE REACTIONS.
D.C.Reitz, J.R.Hollahan, F.Dravnieks and J.E.Wertz.
J. chem. Phys. (USA), Vol. 34, No. 4, 1457-8 (April, 1961).

The reaction products of p-benzoquinone in ethanol and methanol have been identified, by comparison of their hyperfine spectra with those of known semiquinone compounds, as the alkoxyl derivatives.
E.F.W.Seymour

12307 TRITIUM AS AN INTERNAL SOURCE OF RADIATION IN E.P.R. STUDIES OF ORGANIC MATERIALS.
J.Kroh and J.W.T.Spinks.
J. chem. Phys. (USA), Vol. 34, No. 5, 1853-4 (May, 1961).

The spectra of some frozen organic compounds, containing tritium oxide introduced either as an aqueous solution before cooling or by simultaneous condensation from the vapour phase, are compared with the spectra produced by irradiation of the samples from outside. Background spectra from the sample containers are absent but in some circumstances an unwanted OH radical spectrum is produced. [Figs. 1-3 mentioned by the authors are missing from the text].
E.F.W.Seymour

12308 NUCLEAR MAGNETIC RESONANCE OF AMIDES. C.Franconi, R.A.Ogg, Jr and G.Fraenkel.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 543-9 (1960).

9th Colloque Ampére Paper (see Abstr. 4734 of 1961). The p.m.r. spectra of a number of secondary and tertiary amides were determined. It is inferred that the C—N bond has considerable double bond character giving rise to cis-trans isomerism. It is also shown that amides protonate on the oxygen atom.
T.E.Peacock

12309 LONG RANGE CHEMICAL SHIFTS IN ACETO-ACETIC ESTER AND ACETYLACETONE. J. Ranft.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 550-1 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The chemical shifts of the CH_3 lines were calculated using theoreti values for the bond diamagnetic susceptibilities. The agreeme with experiment seems to be good.
T.E.Pe

12310 HIGH RESOLUTION PARAMAGNETIC PROTON R ANCE SPECTRA OF SOME METAL-ETHYL COM POUNDS. G.Klose.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 552 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). T spectrum of tin tetraethyl of a frequency of 25 Mc/s has 3 inte lines with several satellites. These satellites result from the unequal spin coupling of the Sn^{117} isotope with the CH_3 and CH groups. In diethyl selenide, satellites arising from coupling between Se^{77} and the CH_3 and CH_2 groups are not observed.
T E.Pe

12311 THE DYNAMIC POLARIZATION OF NUCLEI IN SOLUTIONS OF FREE RADICALS.
C.Berthet, J.P.Imbaud, P.Ackermann and R.Rondet.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 674-9 (1960
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Th dynamic polarization of nuclei in the free radicals existing in s tions of DPPH in benzene and Perspex (solid solution), and sem quinones in a basic alcholic medium are reported.
W.J.Orville-Th

12312 THE DOUBLE RESONANCE OF A FREE RADICAL DIFFERENT DIRECTING FIELDS. Y-H.Tchao.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 686-90 (196
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Systematic studies of the influence of the directing field on the Overhauser effect are reported for the proton resonances in D
W.J.Orville-T

12313 NUCLEAR MAGNETIC RESONANCE SPECTRUM O THE TRIPHENYLCARBONIUM ION.
R.S.Berry, R.Dehl and W.R.Vaughan.
J. chem. Phys. (USA), Vol. 34, No. 4, 1460-1 (April, 1961).

The proton spin—spin coupling constants originally deduce from this spectrum were incorrect [Journal of Organic Chemis (USA), Vol. 24, 1616 (1959)]. The constants are re-evaluated b complete calculation of the spectrum, choosing values for best with the observed spectrum.
E.F.W.Sey

12314 EFFECT OF ELECTRONEGATIVITY AND MAGNE ANISOTROPY OF SUBSTITUENTS ON C^{13} AND H^1 CHEMICAL SHIFTS IN CH_3X AND CH_3CH_2X COMPOUNDS.
H.Spiesecke and W.G.Schneider.
J. chem. Phys. (USA), Vol. 35, No. 2, 722-30 (Aug., 1961).

An investigation was made of the major contributions whic make up the relative chemical shifts in CH_3X and CH_3CH_2X com pounds. In order to obtain more detailed information, both the carbon and hydrogen chemical shifts were measured. The car shifts were obtained by measuring natural abundance C^{13} reson in the pure liquids; the H^1 resonances were measured on gaseo samples to avoid solvent effects. The results reveal surprisin large contributions to both C^{13} and H^1 shifts arising from magn anisotropy effects of the X substituent. In CH_3X compounds, th contribution to the proton shifts is negative while that to the C^1 shifts is positive. In CH_3CH_2X compounds, these effects contri to the resonance shifts of carbon and hydrogen nuclei in both th methylene and methyl group. When such contributions are allo for, an approximate correlation with the electronegativity of X be obtained, indicating that inductive effects, together with anis effects, account for the major part of the relative chemical shi these molecules. The quantitative determination of inductive p meters of substituents from chemical shift data is, however, s what limited. The presence of a large magnetic anisotropy wit the molecule also affects the nuclear resonance shifts of neigh molecules and gives rise to a "solvent dilution shift"; for the C resonance of CH_3I this amounts to 7.3 p.p.m.

12315 SUBSTITUENT EFFECTS ON THE C^{13} AND H^1 CHEMICAL SHIFTS IN MONOSUBSTITUTED BENZ
H.Spiesecke and W.G.Schneider.
J. chem. Phys. (USA), Vol. 35, No. 2, 731-8 (Aug., 1961).

The origin of the relative nuclear resonance shifts in mon substituted benzenes was investigated. In order to obtain more complete experimental information both C^{13} and H^1 resonance s in a variety of aryl-X compounds were measured. The H^1 reso

...re measured on 5 mole % solutions in cyclohexane to minimize ...nt effects; the carbon shifts were obtained from natural abund... ...C^{13} resonance measurements in the neat liquid. Unambiguous ...nments of both H^1 and C^{13} resonance spectra were made ...ble with the aid of deuterated compounds. The largest reson... ...shifts were observed for the carbon atom directly bonded to X. ...the corresponding CH_3X compounds, these shifts arise ...arily from the inductive and magnetic anisotropy effects of X. ...etic anisotropy effects of X are also observable in both the C^{13} ...H^1 resonances at the ortho position. A very close correspond... ...between C^{13} and H^1 resonances is observed at the para position, ...e the primary contribution to the relative shifts arises from ...ance effects of X. This implies that the proton resonance ...onds to the π-electron density on the carbon to which it is ...ed, and that under favourable conditions, both H^1 and C^{13} ...nance shifts might be employed to obtain information about the ...ctron density distribution in aromatic systems. At the meta ...ion the C^{13} resonance shifts are surprisingly small and uniform, ...ating small or negligible inductive effects due to X, and there ...evident correlation with the meta-proton shifts. Both the C^{13} ...H^1 shifts at the para position show an approximate correlation ...chemical reactivity parameters (Hammett σ constants) but no ...correlation exists for the meta-carbon or meta-hydrogen ...s.

12316 FLUORINE N.S.R. SPECTROSCOPY. II. A "DISTANT" CARBON-13 ISOTOPE EFFECT. G.V.D.Tiers.
...hys. Soc. Japan, Vol. 15, No. 2, 354 (Feb., 1960).
Very precise measurements are described of an isotope effect ...the shielding values for fluorine atoms attached to C^{13} in the ...rine n.s.r. spectrum of CF_3CCl_3, CF_3CO_2H, $CF_2{=}CCl_2$ and ...$Cl{=}CCl_3$. This effect and the spin coupling constants were ...sured for both the $F{-}C^{13}$ and the $F{-}C^{12}{-}C^{13}$ systems.
J.M.Baker

12317 ON THE PROTON CHEMICAL SHIFT IN DEUTERIUM SUBSTITUTED P-XYLENE AND TOLUENE.
...usumoto, J.Itoh, K.Hirota and T.Ueda.
...hys. Soc. Japan, Vol. 15, No. 4, 728-9 (April, 1960).
Observations of the high resolution n.m.r. spectra suggest that shielding of the protons in the methyl group increases in the ...er $CH_3{<}CH_2D{<}CHD_2$.
C.J.Ultee

12318 MAGNETIC SHIELDING CONSTANTS IN HETEROPOLAR DIATOMIC MOLECULES. C.W.Kern and W.N.Lipscomb.
...s. Rev. Letters (USA), Vol. 7, No. 1, 19-20 (July 1, 1961).
For a suitable choice of the vector potential, the magnetic ...elding is expressed in terms of ground-state wave-functions; ...culations for LiH and HF are in reasonable agreement with ...eriment.
R.A.Ballinger

QUADRUPOLE COUPLING CONSTANT OF Li_2. See Abstr. 12150

12319 PARAMAGNETIC RESONANCE ABSORPTION OF THE DIMESITYLMETHYL RADICAL.
B.Chesnut and G.J.Sloan.
...chem. Phys. (USA), Vol. 35, No. 2, 443-4 (Aug., 1961).
The isotropic hyperfine structure of the electron paramagnetic ...sonance spectrum of the dimesitylmethyl radical was observed. ...arly 300 of the 910 theoretical lines have been resolved and ...alysed in terms of the coupling constants of the various nuclear ...ecies. A spin-density distribution throughout the molecule is ...duced from the measurements and is compared with recent ...eoretical calculations.

12320 CUBIC POTENTIAL SURFACES IN THE TRANSITION-STATE THEORY OF UNIMOLECULAR REACTIONS.
B.Slater.
...chem. Phys. (USA), Vol. 35, No. 2, 445-50 (Aug., 1961).
The frequency factor of a unimolcular dissociation rate is ...hanced if the molecular vibrations are loosened during the ...proach to the activated state; this loosening may be regarded as ...fecting the partition function or entropy in the nonreactive degrees ...freedom. These ideas are illustrated here in terms of cubic ...tential surfaces, with examples of linear molecules and of the ...fect of freeing an internal rotation. As a more general but related ...int, the uniqueness of the reaction coordinate of transition-state ...eory is discussed with some reference to isotope effects.

12321 PHOTON DISSOCIATION OF WATER: INITIAL NONEQUILIBRIUM POPULATIONS OF ROTATIONAL STATES OF OH ($^2\Sigma^+$).
I.Tanaka, T.Carrington and H.P.Broida.
J. chem. Phys. (USA), Vol. 35, No. 2, 750-1 (Aug., 1961).
Large relative populations of OH radicals with high rotational quantum number were found in the products of dissociation of water vapour by 10 eV photons; the rotational distribution was changed by the addition to the water of hydrogen or inert gases.
J.Hawgood

12322 INTRAMOLECULAR CHARGE TRANSFER IN AROMATIC FREE RADICALS. H.M.McConnell.
J. chem. Phys. (USA), Vol. 35, No. 2, 508-15 (Aug., 1961).
A theoretical analysis is made of the rate of intramolecular transfer of the odd electron between the two phenyl groups in the mononegative ions of the α,ω-diphenylalkanes, $\phi{-}(CH_2)_n{-}\phi$. The essential features of the calculations are: (a) It is shown that the polymethylene chain can be replaced by a pseudopotential corresponding to an effective direct transfer between the rings. (b) There is a strong tendency for self-trapping of the odd electron on one phenyl ring, or the other, due to solvent polarization and bond distortions in the rings. The self-trapping greatly reduces the rate of intramolecular charge transfer. (c) The intramolecular charge transfer occurs as an electronic resonance effect when a short-lived thermally activated molecular state is formed in which the two rings appear to the odd electron to be equivalent to one another. The activation energy is estimated to be of the order of 1000 cm^{-1}. (d) It is found that the rate of intramolecular charge transfer decreases expontially with the length of the polymethylene chain, the decrease being as much or more than a factor of ten for each added methylene group.

12323 ON THE CLASSICAL APPROXIMATION IN THE STATISTICAL THEORY OF MASS SPECTRA.
H.M.Rosenstock.
J. chem. Phys. (USA), Vol. 34, No. 6, 2182-3 (June, 1961).
Discrepancies between experiment and the predictions of the mass spectra theory assuming the classical approximation are investigated using some model calculations. Results show that the classical approximation is seriously in error, particularly for rate constants of mass spectrometric interest around 10^5 sec^{-1}.
G.I.W.Llewelyn

DISSOCIATION CONSTANT OF LiO^+. See Abstr. 11301

12324 MASS SPECTRA AND METASTABLE TRANSITIONS IN ISOTOPIC NITROUS OXIDES. G.M.Begun and L.Landau.
J. chem. Phys. (USA), Vol. 35, No. 2, 547-51 (Aug., 1961).
The mass spectra of the four species $N^{14}N^{14}O$, $N^{14}N^{15}O$, $N^{15}N^{14}O$, and $N^{15}N^{15}O$ were recorded. The $(NO)^+$ fragment produced was found to be formed by rearrangement, as well as by loss of the end nitrogen. The mass spectrum of each of the nitrous oxides contained ions corresponding to metastable transitions. These ions were shown to arise from both spontaneous and collision-induced dissociation of the parent molecule ion $(N_2O)^+$. The electron impact dissociation of nitrous oxide is discussed.

12325 MOLECULAR STRUCTURE OF DIPHENYLETHERS. H.Shimizu, S.Fujiwara and Y.Morino.
J. chem. Phys. (USA), Vol. 34, No. 4, 1467-8 (April, 1961).
The magnetic resonance spectrum of the methyl protons in 2,2'-dimethyldiphenylether was observed, under high resolution, as two lines of equal intensity, separated by 1.35 ± 0.07 c/s. With negligible coupling between these protons and those on the benzene rings, this splitting indicates that the methyl groups are in non-equivalent positions in the molecule. The proton magnetic resonance spectrum of diphenylether was also measured, the range of splitting being about 30 c/s. The range expected from ring-current theory was computed for various mutual inclinations of the benzene rings, but no model so far proposed gives close agreement with observation.
J.Sheridan

12326 ON THE STRUCTURE OF THE ISOMERS OF N_2F_2. R.Ettinger, F.A.Johnson and C.B.Colburn.
J. chem. Phys. (USA), Vol. 34, No. 6, 2187-8 (June, 1961).
The authors agree with Sanborn (Abstr. 3541 of 1961) that the lower-boiling isomer of difluorodiazine is in trans form but question his infrared assignments. The structure of the higher-boiling isomer is considered to be in doubt. See also following abstract.
R.C.Seymour

12327 COMMENTS ON "ON THE STRUCTURE OF THE ISOMERS OF N_2F_2". R.H.Sanborn.
J. chem. Phys. (USA), Vol. 34, No. 6, 2188 (June, 1961).

Replies to the criticism of his work and points out that the 737 cm^{-1} band in active N_2F_2 is a bending fundamental which is not at the correct frequency for the cis isomer but fits for 1,1-difluorodiazine. R.C.Seymour

12328 ENERGY VALUE OF THE OCTAHEDRAL–TETRAHEDRAL COORDINATION CHANGE. L.I.Katzin.
J. chem. Phys. (USA), Vol. 35, No. 2, 467-72 (Aug., 1961).

The equilibrium $^{oct}(CoCl_2Py_4) = {}^{tet}(CoCl_2Py_2) + 2Py$ for cobaltous chloride solutions in pyridine is followed over a temperature range, yielding $\Delta H = +13.4$ kcal/mole. At 38° C the equilibrium constant is estimated as $(CoPy_2Cl_2)(Py)^2/(CoCl_2Py_4) = 0.04$, and the ΔS for the reaction is about 36.7 eu. It is pointed out that the average bond strength in the tetrahedral species is about 17 kcal greater than for the same groups in the octrahedral configuration, and that the strength of binding and the dissociation energy for the two ligands released according to the equation above are significant factors in determining the equilibrium reaction. Detailed arguments are given against the view that the relative stability of octahedrally and tetrahedrally coordinated complexes, such as the pair discussed, reflect principally the difference in "ligand-field stabilization" of the nonbonding d electrons between octahedral and tetrahedral fields.

12329 CALCULATION OF DEPOLARIZATION RATIOS, ANISOTROPIES, AND AVERAGE DIMENSIONS OF N-ALKANES. R.P.Smith and E.M.Mortensen.
J. chem. Phys. (USA), Vol. 35, No. 2, 714-21 (Aug., 1961).

A general scheme is outlined for the calculation of the anisotropy of the polarizability and the depolarization ratio for alkane chains. Computed results are given for these quantities and also for the mean-square end-end distance and the mean-square radius, for chains of up to 10 carbon atoms. The effects of various weighting-factor approximations, of excluded volume, of temperature and of trans-gauche energy difference are discussed. The theoretical and experimental depolarization ratios are compared and discussed.

12330 INTENSITY ASPECTS AS DETERMINANT OF r'_e-r''_e IN THE BANDS OF THE LANTHANUM OXIDE (LaO) (B → X) SYSTEM. N.Sreedhara Murthy.
Nature (GB), Vol. 190, 430 (April 29, 1961).

A theoretical estimate of $\Delta r_e \cong 0.038$ A is obtained for the difference in the internuclear separations in the B and X levels of lanthanum oxide. W.J.Orville-Thomas

12331 DETERMINATION OF EXCITED-STATE DIPOLE MOMENTS OF AZULENE.
W.W.Robertson, A.D.King, Jr and O.E.Weigang, Jr.
J. chem. Phys. (USA), Vol. 35, No. 2, 464-6 (Aug., 1961).

The absorption spectra of three transitions of azulene were observed in a number of polar and nonpolar solvents. These frequency shifts were used to evaluate the constants in an equation developed by McRae representing solvent–solute interactions, and the constants gave the change in dipole moment for each of the transitions.

12332 HOMOPOLAR DIPOLE.
C.A.Coulson and M.T.Rogers.
J. chem. Phys. (USA), Vol. 35, No. 2, 593-9 (Aug., 1961).

Numerical tables for the homopolar dipole or overlap moment $\mu_{h.d.}$ associated with various molecular orbitals (MO's) are presented. The tables include values of $\mu_{h.d.}/R$ for the common MO's constructed from linear combinations of atomic orbitals (the LCAO approximation), one of which is an 1s, 2s, $2p_\sigma$, $2p_\pi$, 3s, or $3p_\sigma$ orbital. The calculations employ approximate atomic orbitals of the Slater type. Formulae for $\bar{x}_{AB}$, the x coordinate of the centroid of negative charge for an electron in an MO, are given as functions of the parameters

$$p = \tfrac{1}{2}R(\zeta_A + \zeta_B) \text{ and } t = (\zeta_A - \zeta_B)/(\zeta_A + \zeta_B),$$

where R is the internuclear distance, $\zeta(n - \delta)$ is the effective nuclear charge found by the Slater rules, and $(n - \delta)$ is an effective quantum number. Values of $\mu_{h.d.}/R$ are also given for some MO's in which one AO is a hybrid. The variation of $\mu_{h.d.}$ with the parameters p and t is shown graphically for certain MO's. The overlap moment $\mu_{h.d.}$ has been computed for various chemical bonds by use of the tables. Overlap integrals for the AO combinations 1s-$3d_\sigma$, 2s-5s, 2s-$5p_\sigma$, $2p_\pi$-$3d_\pi$, and 3s-3s are computed since these were not available in the literature over the necessary range of the variables.

12333 DIPOLE MOMENTS OF α,ω-DIBRIMOPARAFFINS AND THEIR TEMPERATURE DEPENDENCE.
H.J.G.Hayman and J.Eliezer.
J. chem. Phys. (USA), Vol. 35, No. 2, 644-8 (Aug., 1961).

The dipole moments of the eight α,ω-dibromoparaffins from dibromopropane to dibromodecane together with those of n-[illegible] and n-butyl bromide were determined at 25° and 64° C in benzene solution. The results obtained are in good quantitative agreement with the theory developed previously on the assumption that the flexibility of these molecules is due to independent restricted rotations about the various C–C bonds. The data obtained were insufficient for determining the form of the potential barrier restricting these rotations, but could be interpreted in terms of the usual picture of gauche-trans rotational isomerism on the assumption that the energy of a gauche isomer is 0.40 ± 0.12 kcal/mole [illegible] than that of the corresponding trans isomer, except for the [illegible] of the CH_2Br groups when the energy difference is somewhat less, 0.34 ± 0.14 kcal/mole.

12334 PERMANENT DIPOLE MOMENTS OF SATURATED HYDROCARBONS. R.Ferreira.
J. chem. Phys. (USA), Vol. 35, No. 2, 755 (August, 1961).

Using the values 2.28 and 2.63 for the electronegativities of hydrogen and sp_3 carbon, the ionicities of $C(sp_3)$–H bonds are found to be 0.038 ± 0.004 e.u. for a primary C atom, 0.050 ± 0.005 e.u. for a secondary and 0.073 ± 0.007 e.u. for a tertiary carbon atom. With the value 1.01 A for the $C(sp_3)$–H bond distance the C–H projection bond moments are found to be 0.20 ± 0.02, 0.26 ± 0.03 and 0.38 ± 0.04 D. The resultant dipole moments of propane and n-butane are then found to have the values 0.04 ± 0.02 and 0.18 ± 0.04 D respectively. The experimental values are 0.081 and 0.132 D. T.E.Ba[illegible]

12335 A SELF-CONSISTENT SET OF MOLECULAR PARAMETERS FOR NEON, ARGON, KRYPTON AND XENON. G.Boato and G.Casanova.
Physica (Netherlands), Vol. 27, No. 6, 571-89 (June, 1961).

An attempt at determining a self consistent set of parameters ϵ and σ for heavier inert gases was made on the assumption of the validity of a universal two-body law of interaction and therefore of the applicability of the quantum theorem of corresponding states. Vapour pressure data on isotopic pairs and other new experimental data are used for this purpose. The new set of parameters is used for plotting various reduced properties versus the quantum parameter $\Lambda^* = h/\sigma\sqrt{m\epsilon}$. The experimental data used for constructing the plots were carefully selected among the available and most recent literature. The theorem of corresponding states is found to be obeyed to a high degree of approximation. A critical comment on the use which can be made of the newly determined parameters is finally given.

12336 REACTIVE SCATTERING IN CROSSED MOLECULAR BEAMS. K ATOMS WITH CH_3I AND C_2H_5I.
D.R.Herschbach, G.H.Kwei and J.A.Norris.
J. chem. Phys. (USA), Vol. 34, No. 5, 1842-3 (May, 1961).

Observed angular distributions of KI formed by capture in CH_3I and C_2H_5I by K atoms in a crossed beams experiment are analysed (Abstr. 6064 of 1961) kinematically. For both reactions the total cross-section is about 10 A^2, and the activation energy less than 0.3 kcal/mole. M.R.C.M[illegible]

12337 q-DIMENSIONAL EXCLUDED VOLUME IN RANDOM FLIGHT CHAINS. C.von Frankenberg and R.E.H[illegible]
J. chem. Phys. (USA), Vol. 35, No. 2, 503-7 (Aug., 1961).

The dependence of $\langle r^2 \rangle$ on the number of links in a random is calculated for an arbitrary number of dimensions from generalizations of the treatments of James and Fixman. The results are compared with those from other approaches. The extension of James theory to include second-order corrections is briefly discussed.

12338 EXTENSION OF HIGH POLYMER MOLECULE AND ENERGY CHANGE BY MIXING. H.Mizutani.
J. Phys. Soc. Japan, Vol. 16, No. 2, 282-90 (Feb., 1961).

The change in intermolecular potential energy produced by mixing some low molecular liquids, which are considered as substitute for the chain elements of a polystyrene molecule, with several non-polar solvents and the extension of the polystyrene molecule in these solvents were measured, and the results were

d with the theory (Abstr. 8865 of 1961). Determination of gy change was made by means of a calorimetric method and e extension of polystyrene by measuring the intrinsic of the solution. It was found that the variation of the ns of polystyrene in different non-polar solvents is mainly ied by the difference in the energy change effected by mix- nzene, the side group of polystyrene, with the solvents.

9 THE EFFECT OF IMPURITIES ON THE MOLECULAR WEIGHT DISTRIBUTIONS OF ANIONIC POLYMERS. fino and F.Wenger.
. Phys. (USA), Vol. 35, No. 2, 352-8 (Aug., 1961).
deactivating influence of impurities in anionic polymeriza- considered from the point of view of the ultimate molecular listributions obtained with various systems. With the tion that initiation is much faster than propagation, theore- pressions for the weight distribution functions and the to-number average chain length ratios are derived for the n which mono- and bifunctional growing chains are subjected out the course of polymerization to given, fixed ratios of er to impurity concentrations. The relationships obtained wn to be applicable to systems of practical interest. The lar weight distributions of both mono- and bifunctional polymers derived from the foregoing model are found to n with increasing impurity content in the monomer supply. olecular weight distributions for the latter are narrower ose for the former at corresponding levels of impurity content. oderate degrees of deactivation, the weight distribution n for bifunctional polymers exhibits the characteristic um as well as the rudiments of a second relative maximum er molecular weight.

340 TIME DEPENDENCE OF THE STATISTICAL MOLECULAR WEIGHT DISTRIBUTION OF THE POLY- RESULTING FROM VINYL POLYMERIZATION. anda and R.K.Pathria.
m. Phys. (USA), Vol. 35, No. 2, 630-5 (Aug., 1961).
he problem of the variation with time of the statistical distri- in a polymer resulting from vinyl polymerization is investi- . Starting from the general formula for the number distri- function of the polymer increment, formed during the time val t to t + δt, an expression is obtained for the over-all distri- n in the material polymerized up to a particular stage of the ion. Expressions are also obtained for the various averages ining to the over-all material. The integrals occurring in the formulae cannot, in general, be evaluated in a closed form. lts are obtained in such cases by having recourse to the yshev method of numerical integration. A discussion of the esting features that emerge out of this investigation is also n.

2341 STATISTICS OF ORIENTATION EFFECTS IN LINEAR POLYMER MOLECULES. E.A.DiMarzio.
em. Phys. (USA), Vol. 35, No. 2, 658-69 (Aug., 1961).
This paper is concerned with the effects of orientation on the binatorial term g for the number of ways to pack together N_x ar polymers (x mers). Accordingly g is evaluated as a function ie number of molecules in each permitted direction for the case traight rigid rods. The permitted directions can be continuous hat g is derived as a function of the continuous function $f(\vec{t})$ ch gives the density of rods lying in the solid angle $\Delta\vec{t}$, or the mitted directions can be discrete so that g is the number of ways ack molecules onto a lattice. To illustrate the usefulness of the entation dependent combinatorial terms, liquid crystals are cussed. Another phase is found to exist in addition to the viously predicted nematic phase. This phase is tentatively ntified with the cholesteric phase. A procedure is developed for calculation of the orientation dependent combinatorial term ociated with the packing together of molecules of arbitrary pe. A very approximate application of this procedure results in approximate expression for the combinatorial term which allows to predict qualitatively the change in the entropy of packing a function of stretch. It is found that the entropy of packing has proper behaviour to explain the initial deviation of the experi- tal stress-strain curve from the previous theoretical dictions.

12342 MOLECULAR VIBRATIONS AND STRUCTURES OF HIGH POLYMERS. I. GENERAL METHOD OF NORMAL COORDINATE TREATMENT BY INTERNAL COORDINATES AND INFRARED FREQUENCIES AND CONFORMATIONS OF $(-CH_2-)_n$, $(-CH_2-O-)_n$, and $(-CH_2-O-CH_2-)_n$. T.Miyazawa.
J. chem. Phys. (USA), Vol. 35, No. 2, 693-713 (Aug., 1961).

The normal coordinate treatment of the $(-A-)_n$ chain is made in terms of internal symmetry coordinates and optically active frequencies of $(-CH_2-)_n$ are calculated for various chain conformations. The calculated frequencies of polyethylene and cyclopentane agree with the observed values. The low infrared frequency was found to be structure sensitive. The infrared band of polytetrafluoroethylene at approx 100 cm^{-1} may be primarily due to this mode. The low infrared frequencies of polyoxymethylene are compared with the corresponding frequencies of $(-A-)_n$ calculated for various conformations and are found to be in accord with Huggins' model but not with the planar zigzag structure. The normal coordinate treatment of $(-A-B-)_n$ is made taking into account the torsional potential as well as the stretching and bending potentials, and vibrational assignments of polyoxymethylene are made. For poly- (ethylene glycol) a structure model is proposed. This model is made up of only the gauche configuration throughout the helical chain and contains seven chemical units and five turns of the helix per fibre period. The polarized infrared spectra of this polymer were measured in the region 800-400 cm^{-1} and the observed skeletal frequencies are compared with the corresponding frequencies of $(-A-)_n$ calculated for various conformations. The infrared spectra were found to be in accord with the model proposed. The infrared spectra in the rocksalt region were also reasonably assigned. Finally a general method of treating any infinite helical chain belonging to dihedral group is presented in terms of real internal symmetry coordinates. The G or F matrix of an infinite order is factored into the set of matrices $G(\delta)$ or $F(\upsilon)$ associated with the phase difference δ. The method is explained for the cases of polyoxymethylene and poly-(ethylene glycol).

12343 THE DIPOLE MOMENT AND END-TO-END LENGTH OF THE ISOTACTIC VINYL POLYMER. I. MUTUAL DEPENDENCE BETWEEN DIPOLE MOMENT AND END-TO-END LENGTH. T.Mori.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1482-8 (Aug., 1960).

The formulae for mean-squared dipole moment and end-to-end length of the isotactic vinyl polymer are derived. The polymer model used in these derivations is similar to Lifson's (Abstr. 756 of 1959), but the dependence of these mean-squared quantities on molecular weight of the polymer is considered in the present calculations. The two mean-squared quantities, dipole moment and end-to-end length, are not independent of each other, and it is pointed out that they are connected by a simple expression. On the other hand, the present treatment is useful to see the corrected Staudinger's viscosity rule from a new point of view.

12344 THE DIPOLE MOMENT AND END-TO-END LENGTH OF THE ISOTACTIC VINYL POLYMER. II. A SPECIAL SIMPLIFIED MODEL AND NUMERICAL CALCULATIONS. T.Mori.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1638-45 (Sept., 1960).

In the preceding paper, fundamental formulas for $\langle\mu^2\rangle_0$, $\langle R^2\rangle_0$, $\langle\mu^2\rangle$ and $\langle R^2\rangle$ are derived. In the present paper, these formulas are brought into the more convenient forms for numerical calculations, and the square well potential of internal rotation of polymer and a linear function $\varphi'(\varphi)$ are introduced. The results of calculations explain that $\langle\mu^2\rangle/n\mu_0^2$ must be 0.3 ~ 1.0 when the effective bond length is 5 ~ 10 A. These values agree satisfactory with experimental data.

12345 DIELECTRIC β-RELAXATIONS IN SOME LINEAR HIGH POLYMERS. K.Yamafuji.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2295-306 (Dec., 1960).

The dielectric β-dispersions in the amorphous part of the linear high polymers may be roughly classified into two categories according to their mechanisms: the first are the dielectric dispersions in the polymers which have long flexible dipoles, and the second are those which have rather short dipoles rigidly attached to their main chains. While the β-dispersions in the polymers of the first group are inferred to be mainly due to the micro-Brownian motions of their long dipoles, no convincing theory referring to the mechanism of those of the second group has been proposed up to present. In this paper, the dielectric β-dispersions of these second group polymers are investigated. The approximate magnitudes of some quantities appearing in the theory are evaluated by the

observed values obtained from the mechanical dispersion. Taking account of the phenomenological nature of the theory, agreements between the theory and the observations may be satisfactory.

DETERMINATION OF THE DISTRIBUTION CURVE OF THE LENGTHS OF LINEAR MACROMOLECULES IN SOLUTION BY DIELECTRIC ABSORPTION. See Abstr. 11766

MOLECULAR BEAM FOR THE STUDY OF HIGH-TEMPERATURE-GAS COLLISION PROCESSES. See Abstr. 11

SOLID-STATE PHYSICS

12346 CRITICAL PERCOLATION PROBABILITIES (BOND PROBLEM).
V.A.Vyssotsky, S.B.Gordon, H.L.Frisch and J.M.Hammersley.
Phys. Rev. (USA), Vol. 123, No. 5, 1566-7 (Sept. 1, 1961).

Monte Carlo estimates of the critical percolation probabilities for the "bond problem" are presented for a number of two- and three-dimensional lattices. The agreement between the Monte Carlo estimates and the estimates obtained by Domb and Sykes (Abstr. 7512 of 1961) obtained from series expansion for the mean cluster size are quite satisfactory.

12347 X-RAY STUDY ON THE BINDING PROPERTIES OF Cu_2O AND Ag_2O CRYSTALS. T.Suzuki.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2018-24 (Nov., 1960).

Crystallographical properties of the chemically prepared powder samples of Ag_2O and Cu_2O were investigated by an X-ray diffractometer, in relation to their bonding characters. The lattice constant is 4.720 ± 0.004 A for Ag_2O and 4.268 ± 0.001 A for Cu_2O. The thermal expansion coefficient of the lattice is 1.9×10^{-5} for Cu_2O. The root-mean-square amplitude of the thermal lattice vibration is determined as 0.26 A for Cu_2O and 0.40 A for Ag_2O at room temperature. The mean lattice strain is 1.4% for Ag_2O and 0.15% for Cu_2O, respectively. The thermal decomposition of Ag_2O was also observed. The obtained results suggest that the binding force between metallic and oxygen atoms is much weaker in Ag_2O than in Cu_2O, which would not be expected from the purely ionic model for the present crystals.

12348 MULTIPOLE INTERACTION STABILIZING CUBIC MOLECULAR CRYSTALS. T.Kihara.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1920-4 (Nov., 1960).

The stability of several cubic molecular crystals is investigated on the basis of multipole interaction between the molecules. The stability of the cubic close-packed structure of heavy rare-gas crystals is due to the repulsion between electrical octapoles induced in atoms in the hexagonal close-packed structure. The face-centred cubic structures of carbon dioxide and cyclohexane hexahalides and the body-centred cubic structures of silicon tetrafluoride and hexamethylene-tetramine are configurations with the maximum electrostatic attraction between permanent charge distributions in the molecules. Pingpong balls containing two or four pieces of magnet represent these molecules with permanent multipoles; and it is demonstrated that a proper "crystal" of such balls (suspended in water) is stable.

12349 RATIO OF ATOMIC STOPPING POWER OF GRAPHITE AND DIAMOND FOR 1.1 MeV PROTONS. S.D.Softky.
Phys. Rev. (USA), Vol. 123, No. 5, 1685-91 (Sept. 1, 1961).

The theory describing energy loss of heavy charged particles in matter predicts that different physical or chemical forms of the same element will have slightly different stopping powers. Since two different forms of a pure element exhibit the same nuclear scattering cross-section, it has been possible to measure the relative atomic stopping power of graphite and diamond by observing the yields of back-scattered protons from thick targets. The atomic stopping power of graphite was measured to be 1.0604 ± 0.0090 times that of diamond (for 1.1 MeV protons). Using the theoretical density of graphite, a calculation based on this result and Brandt's version of stopping theory yields the result that the molecular polarizability of graphite is 4.9 times that of diamond. If this calculation is made using the measured density of graphite, this polarizability ratio is 1.5, in agreement with the theoretical value.

12350 ON THE MEAN POTENTIAL V_0 IN ALUMINIUM. C.Kurylenko.
Cahiers de Phys. (France), Vol. 15, 102-4 (Feb., 1961). In Fre

Analysis of the X-ray K absorption spectra of Al obtained Rudström (Abstr. 7067 of 1958) indicated that the inner potentia Al is 12.91-13.06 ± 2.14 eV, assuming that the "metallic" val of Al is 1.30-1.33. The fine structure of the K absorption edge found to be in agreement with the theoretical predictions of Fu [Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 39, No. 4, 189 (Feb., 1956)]. J.Th

NUCLEAR ORIENTATION OF Nd^{147} IN NEODYMIUM ETHYLSULPHATE. See Abstr. 12147

LATTICE MECHANICS

12351 TOTAL CROSS SECTION OF LEAD FOR SLOW NEUTRONS. M.F.Collins and G.Dolling.
Phil. Mag. (GB), Vol. 6, 485-9 (April, 1961).

A beam of filtered neutrons with a mean wavelength of 8.4 was used to measure the total cross-section of lead as a functi temperature from 290°K to 840°K. The cross-section is found vary linearly with temperature in both solid and liquid phases t within 1°K of the melting point. There is a jump in cross-sect at the melting point of (9.4 ± 0.6)%. The results in the solid ar in agreement with predictions based on the Debye theory.

12352 A NEW PICTURE OF THE VIBRATION OF LINEAR LATTICES. J.Hori.
J. Phys. Soc. Japan, Vol. 16, No. 1, 23-35 (Jan., 1961).

A new version of the method of the transfer matrix is pres which largely simplifies the derivation of eigenfrequency equati on the one hand, and gives rise to a very simple and vivid pictu (vector picture), on the other hand, of the normal vibration for linear isotopic lattices. By using this version and the vector p the wave forms of the extra- and in-band vibrations of the latti containing a small amount of impurity and the eigenfrequency spectrum of generalized diatomic lattices are discussed, obtai some interesting conclusions.

12353 NORMAL FREQUENCIES AND AMPLITUDES AND THE HEAT CAPACITY OF KBr.
O.A.Demidenko, Z.A.Demidenko and K.B.Tolpygo.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 728-42 (1958). In Ukra

Calculated, taking into consideration the deformation of th ions, by the method — and using parameter values — given by Tolpygo (1950-4). The calculations were carried out for 28 va of the wave vector, which gives the values of the frequencies a amplitudes for 728 points, uniformly (at $\frac{1}{8}$ of every edge) filling the cell of the reciprocal lattice. The normal frequencies and amplitudes are given of the dipole moments caused by the disp ments of ions p_s and their polarizations P_s. For a set of direc of change in the wave vector $\vec{k}$ the graph of $\omega_\alpha(k)$ is given. Th general nature of the curves and the amplitude changes in KBr very similar to those obtained for NaCl and KCl but in compar with NaCl, a great effect is exerted by P_s the dipole moment o K^+, and the anisotropy of the crystal is more pronounced. On basis of these data, the frequency distribution curve $N(\omega)$ is fo and the thermal capacity of KBr calculated for ten temperature values, beginning with 10°K. The results are compared with th

mental data. A comparison with Debye's theory leads to the ice that the characteristic temperature Θ_D should be consider- owly changing function of the temperature.

ABSORPTION OF SOUND IN INSULATORS.
354 T.O.Woodruff and H.Ehrenreich.
Rev. (USA), Vol. 123, No. 5, 1553-9 (Sept. 1, 1961).
he theory of sound attenuation in structurally perfect dielec- rystals is extended and applied to recent experiments . 11953 of 1959; 7867 of 1960) on the absorption of acoustic in crystalline quartz at frequencies from 10^9 to 2.4×10^{10} c/s. ound wave is assumed to vary the frequencies of the thermal ns adiabatically, and the complete Boltzmann equation is used ermine the response of the thermal phonon distribution to this bance. The rate of energy transfer from the thermal phonons temperature bath is computed. In the steady state, energy is ied by the driving sound wave to the thermal phonons at the rate, which gives the attenuation. Relaxation times are ded for N and U processes. Since the effect of the sound wave hermal phonon depends on the relative polarization and wave- er vectors of both, the phonon distribution in a small spatial n tends to relax to a new temperature T' which is determined quiring local conservation of the total energy to first order. resent treatment leads to better understanding of the rapid ase in attenuation with decreasing temperature in the range in the sound-wave period becomes comparable to the average ation time of the thermal phonons.

DYNAMICAL THEORY OF ULTRASONIC ATTENUATION
355 IN METALS. N.Takimoto.
r. theor. Phys. (Japan), Vol. 25, No. 3, 327-52 (March, 1961).
A detailed investigation is given of the ultrasonic attenuation ned by the dynamical properties of conduction electrons. It is ed out that the ultrasonic attenuation arises from the same anism as is responsible for the attenuation of collective lations in a conduction electron system, known as Landau' s uation in some cases. Applying the electromagnetic dispersion ions in metals to the problem, the attenuation constants are ed, and at the same time, the effects of conduction electrons und velocities are investigated. Some discussions are given e relation between the results obtained and those of Pippard. tr. 9499 of 1955). The parallelism of the present phenomenon the anomalous skin effect is pointed out and the attenuation tants are derived for the case where the energy of a conduction ron is an arbitrary function of the wave vector. As a corollary, nost general expression for Landau' s diamagnetic susceptibil- s derived with some applications.

ermal Properties

HEAT CAPACITY OF A SINGLE CRYSTAL OF
.2356 $MnCl_2.4H_2O$. H.Forstat, G.O.Taylor and B.R.King.
hys. Soc. Japan, Vol. 15, No. 3, 528 (March, 1960).
This was measured in the range 1.17-4.43° K, and a λ-type naly was observed at 1.60° K, the temperature of the antiferro- netic—paramagnetic transition; the magnetic entropy change e transition is estimated as 3.50 cal $mole^{-1}$ deg^{-1}.
J.Hawgood

THERMODYNAMIC PROPERTIES OF YTTERBIUM IRON
RNET. See Abstr. 12541

SPIN-WAVE CONTRIBUTION TO SPECIFIC HEAT IN CANTED
N ARRAYS. See Abstr. 12509

CATION MOBILITY AND THERMAL CONTRACTION
.2357 IN AgI. R.T.Payne and A.W.Lawson.
hem. Phys. (USA), Vol. 34, No. 6, 2201-2 (June, 1961).
The pseudothermodynamic relationships, as derived from the tinuum theory of diffusion, between enthalpy, entropy, and volume ctivation are tested by a consideration of the available thermal ansion and compressibility data for AgI, for which the coefficient hermal expansion is negative. Qualitatively the relationships substantiated but quantitatively the test is less satisfactory for of reliable experimental data. W.Good

THERMAL CONDUCTION IN FERROELECTRIC
12358 CERAMICS. I.Yoshida.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2211-19 (Dec., 1960).
Apparatus was constructed and measurements were made on the thermal conductivity of insulating crystals over the temperature ranges from −200° to 600° C. For the lower temperature range, the absolute measurement was used, while for the higher one, the comparative method was adopted. The thermal conductivities of ferroelectric $PbTiO_3$ and antiferroelectric $PbZrO_3$ showed a rather large step-wise increase, in contrast to the case of $BaTiO_3$, as they passed into the paraelectric state. Discussions are given of the relation between the magnitude of thermal conductivity and the crystal structure. It is pointed out that the anharmonic potential for the smaller ions should be responsible for the scattering of phonons in these substances.

SOLID-STATE RESEARCH AT LOW TEMPERATURES.
12359 III. THERMAL CONDUCTION IN INSULATORS; PARAMAGNETISM; DIELECTRIC LOSSES RELATED TO CHEMICAL LATTICE IMPERFECTIONS. J.Volger.
Philips tech. Rev. (Netherlands), Vol. 22, No. 8, 268-77 (1960-61).
For Pt II, see Abstr. 7511 of 1961. Just as the residual resistance of a metal depends on the scattering of electrons by lattice imperfections, the thermal conductivity of insulators at low temperature is determined by the scattering of phonons by the same imperfections. The behaviour of a substance is also determined by the way in which the phonon spectrum varies with temperature. As an example, the behaviour of bismuth telluride is discussed. After dealing with the subject of paramagnetic relaxation, the author discusses the importance of the temperature on the application of paramagnetic resonance and its significance in connection with a solid-state microwave amplifier (maser). Dielectric losses due to polarization mechanisms of very low activation energy (< 0.1 eV) and which can therefore only be studied at low temperatures, are found in such substances as impure quartz and non-stoichiometric or impure oxidic simiconductors.

THERMAL CONDUCTIVITY OF NORMAL AND SUPER-
12360 CONDUCTING LEAD ALLOYS. P.Lindenfeld.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 613-15 (June 1, 1961).
Measurements were made on alloys containing up to 6% In or Bi, and the lattice thermal conductivity K_g deduced. It is concluded that the lattice resistivity $W_g = 1/K_g$ is increased far more by impurity concentration c in the normal state than in the superconducting state: $d W_{gn}/dc \cong 40\, d W_{gs}/dc$. R.G.Chambers

ELECTRON STATES

COMMENT ON THE CALCULATION OF ZERO-FIELD
12361 SPLITTINGS. R.McWeeny.
J. chem. Phys. (USA), Vol. 34, No. 3, 1065-6 (March, 1961).
Reference is made to a previous note (Abstr. 4939 of 1961) on the general theory of electron spin—spin coupling with special reference to the triplet state of naphthalene. Difficulties in integral evaluations have since been pointed out and a reappraisal of the earlier work is carried out leading to the same results subject to certain interpretations of integrals. The latter then allow the previous point approximation of point charges to be retained.
G.F.J.Garlick

SOLUTION OF SCHRÖDINGER EQUATION FOR A
12362 PERIODIC LATTICE. L.Eyges.
Phys. Rev. (USA), Vol. 123, No. 5, 1673-84 (Sept. 1, 1961).
A new method is presented for solving the problem of one electron in a periodic potential; it is discussed in this paper mainly for $\vec{k} = 0$, although it can be generalized to other $\vec{k}$. The periodic potential is considered to be generated by spherically symmetric "atomic" potentials at each lattice site; this does not mean of course that the total potential near a lattice site need be spherically symmetric. The method has its origin in the observation that (for $\vec{k} = 0$) the equation for $C(\vec{K}_i)$, the Fourier coefficient of the wave-function, becomes just the momentum-space Schrödinger equation when the lattice spacing becomes infinite. This latter equation is separable into a radial part, and an angle-dependent part expressible in spherical harmonics. This suggests that it would be advantageous

to expand the $C(\vec{K}_i)$ for finite lattice spacing similarly, into radial functions $C_l(K_m)$, where K_m is the magnitude of the m-th smallest reciprocal lattice vector, and into an angle-dependent part expressible (for cubic lattices) by Kubic harmonics. This is done and the Schrödinger equation for the system becomes a set of homogeneous linear equations for the $C_l(K_m)$, with a corresponding secular determinant for the eigenvalues. The method has been tested numerically, as a function of lattice spacing and potential strength, for S-like states, when the "atomic" potentials are exponential ones, and the lattice is body-centred cubic. In many cases it turns out that one can solve the periodic potential case more easily and more accurately than one can solve for the isolated atom. This is because as the lattice spacing gets large the successive K_m became more and more closely spaced and this leads to larger and larger secular equations. The wave-functions as well as energies are given for most lattice spacings to considerable accuracy (three to seven significant figures). When the lattice spacing gets large and the equations approach those for the isolated atom, the author shows how one can use the atomic momentum space functions as variational functions, in the same spirit as the usual tight-binding approximation (as applied for $\vec{k} = 0$). The present method has the considerable advantage that it bypasses the usual difficulties with that approximation — near-neighbour approximations and calculation of overlap integrals — and permits an easy and accurate evaluation of the variational expression as a sum over the K_m.

12363 THE USE OF THE DIFFUSE REFLECTION SPECTRA IN DETERMINATION OF THE FORBIDDEN ENERGY GAP OF POWDER SAMPLES. É.É.Godik and B.F.Ormont.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3017-19 (Dec., 1960).
In Russian.

The diffuse reflection spectra of the binary system $(ZnSe)_x$—$(CdSe)_y$ were obtained in the visible region. From these spectra, the forbidden energy gap was deduced in the same way as by Fochs (Abstr. 2091 of 1956). [English translation in: Soviet Physics–Solid State (USA), Vol. 2, No. 12, 2680-2 (June, 1961).]
A.Tybulewicz

12364 THE ELECTRONIC STRUCTURE OF DISORDERED SYSTEMS. S.F.Edwards.
Phil. Mag. (GB), Vol. 6, 617-38 (May, 1961).

The problem of the states of electrons moving under the influence of disordered scattering centres is discussed in the simplest case of one dimension and weak interaction. It is shown how to define a density of levels n(E) and an energy and momentum density $\rho(k, E)$ and the variation of those functions from the case of completely disordered scattering centres to the completely ordered case is discussed. In the weak interaction case it is long-range order which dominates the problem and the effect of even slight disorder results in the appearance of states inside the energy gap of the ordered system.

12365 COLLISION BROADENING OF THE LANDAU LEVELS. T.Ohta and T.Miyakawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1378-80 (Dec., 1960).

The scattering probability of a carrier at the bottom of a Landau level by a static impurity potential diverges. A tentative method is suggested for avoiding the divergence, and the collision broadening is calculated by solving the standard integral equation with an iteration method. The case of an isotropic mass is considered and all spin effects are ignored. Comparison is made with experimental results for Ge and InAs. L.Pincherle

12366 GROUND STATE OF AN ISING FACE-CENTRED CUBIC LATTICE. A.Danielian.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 670-1 (June 15, 1961).

The degeneracy of the ground state is $\exp(AN^{1/3}\ln 2)$, where N is the number of sites and A a constant. E.P.Wohlfarth

12367 FERMI SURFACE AND POSITRON ANNIHILATION IN SODIUM. A.T.Stewart.
Phys. Rev. (USA), Vol. 123, No. 5, 1587-8 (Sept. 1, 1961).

The angular correlation of photons from positrons annihilating in polycrystalline sodium was measured. The results show: (a) in comparison with a free-electron theory, the Fermi surface in Na is probably anisotropic by an amount of the order of 5% of p_F; (b) the probability of annihilation is not very velocity-dependent over the range of conduction-electron velocities in Na. This is not inconsistent with the calculations of either Daniel and Friedel or of Kahana.

12368 SOME REMARKS ON COLLECTIVE DESCRIPTIO ELECTRON INTERACTIONS. THE PARTITION FUNCTION. J.Śledzik.
Acta Phys. Polon. (Poland), Vol. 19, No. 3, 383-403 (1960).

The nearly-Hermitian variant of collective description is formulated. The correct partition function is obtained. An eic proof is given that the subsidiary conditions proposed by Kan lead to false results, whereas those of Bohm and Pines yield exact statistical function, provided the renormalizing procedu proposed by the author in a former paper (Abstr. 6245 of 195 applied to their theory.

12369 ON THE POSSIBILITY OF FERROMAGNETISM FO AN ELECTRON GAS. M.Shimizu.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1127 (June, 1960).

The electron gas is shown never to be ferromagnetic, if $m^x/m > 1$. E.P.Woh

12370 QUANTUM STATISTICS OF INTERACTING ELEC GAS IN A STRONG MAGNETIC FIELD. H.Ichimura and S.Tanaka.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 315-26 (March, 19

The quantum statistical mechanical propagator introduce Matsubara (Abstr. 6397 of 1956) is calculated by using the free electron eigenfunction in a magnetic field. This form of the p pagator seems to be appropriate for the treatment of the oscil behaviour of magnetic properties of the interacting electron g a tentative application of this method, the effect of the Coulom teraction between electrons on the de Haas–van Alphen effect discussed.

12371 GROUND-STATE ENERGY OF AN ELECTRON GA A LATTICE OF POSITIVE POINT CHARGES. A.Bellemans and M.De Leener.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 603-4 (June 1, 1961).

A preliminary report on the extension of the calculation o ground state energy for an electron gas of high density with a uniform positive background due to Gell-Mann and Brueckner (Abstr. 6372 of 1957) to the case of a cubic lattice of positive charges. The effect of the lattice is treated to the lowest orde in lattice–electron coupling with Coulomb divergences summe out in the usual way. The authors express surprise at the agr obtained with the results of the linearized self-consistent calcu due to Wigner and Huntington (1935). S.Do

PERIODIC ADIABATIC VARIATIONS IN ELECTRON GAS. See Abstr. 11713

12372 THE INFLUENCE OF A GASEOUS DISCHARGE ON THE CONTACT POTENTIAL OF METAL SURFAC G.Nadzhakov, S.Balabanov and V.Dzhurova.
C.R. Acad. Bulg. Sci., Vol. 13, No. 6, 673-6 (Nov. - Dec., 1960
In Russian.

The change in contact potential was measured by the Zis method at 800 c/s to an accuracy of 10mV. All specimens of A Al, In, and Ga showed an increase in work function after the di charge. A small voltage of ± 4 V applied to the sample during discharge produced a change in contact potential of the same s as the applied voltage, but the size of the change was much gr for negative ion adsorption. M.G.Pri

DEFECT PROPERTIES

12373 ASSOCIATION OF VACANCIES WITH CALCIUM IMPURITIES IN POTASSIUM CHLORIDE CRYSTA T.Ninomiya.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1601-6 (Sept., 1960).

Measurements were made on the d.c. conductivity and die loss in quenched KCl crystals doped with small amount of CaC The evidence for formation of higher complexes was obtained the decay of the conductivity during annealing after quenching. was also found that there exists a relation between the number free vacancies, n_v, and that of impurity–vacancy associated p n_p, during the decay at a fixed temperature,

$$n_p = K' n_v^{1.92}.$$

The number of the free vacancies was found to decay exponenti with time. The activation energy for the decay is estimated to 0.63 ± 0.1 eV.

...74 FORMATION OF PORES IN ANNEALED KCl—KBr CRYSTALS.
K ...tvodovskaya, M.S.Ivankina and I.Ya.Melik-Gaikazyan.
...i. ...llografiya (USSR), Vol. 5, No. 2, 324-5 (March-April, 1960).
...sian.
...fter the annealing of equimolar KCl—KBr crystals at 600°C ...es up to 75 hr, pores with the appearance of negative ...ls were observed. Their presence is attributed to the ...gation of vacancies on inherent defect structures. [English ...ation in: Soviet Physics—Crystallography (USA), Vol. 5, ... 303-5 (Sept.-Oct., 1960)]. R.F.Peart

...375 DISTRIBUTION OF INTERSTITIALS AND VACANCIES PRODUCED BY AN INCIDENT FAST NEUTRON.
...shida.
...s. Soc. Japan, Vol. 16, No. 1, 44-50 (Jan., 1961).
...he distribution of the interstitial—vacancy (I—V) pairs pro... in such a substance as Ge by successive knock-on is ...ssed. Calculation of the distribution is performed based on ...rmula proposed by Bohr, and Seitz and Koehler (Abstr. 3471 of ... and applying the Monte Carlo Method. The ratio of the close ...pairs to the total I—V pairs produced by a 10^4 eV first ...ed-on atom is about 60%. Taking into account the replacement ...ion, a decrease of about 40% in the total number of the I—V ... is obtained and the ratio becomes 30%. The decrease in the ... number reduces the difference between the total number ...ed from calculation and that obtained by experiment. The ...ving results are also obtained. The interstitials and vacancies ...distributed in several groups. They exist in the region ...oped by a sphere of from about 50 to 100 atomic distances in ...eter. There is no tendency for the concentrated damaged ...n to spead in the incident direction of the first knocked-on ... and for the interstitials to distribute themselves in the outer ...of the concentrated damaged region.

...2376 LATTICE PARAMETER STUDIES OF IMPURITY EFFECTS ON PLASTIC PROPERTIES OF LITHIUM ...ORIDE. W.L.Phillips, Jr.
...ppl. Phys. (USA), Vol. 32, No. 4, 751-2 (April, 1961).
Lattice parameter–temperature curves were obtained for LiF ...tals that had been slowly cooled and others that had been ...dly cooled from 500°C after annealing. The differences are ...ibed to precipitation of impurities in the slow-cooled specimen, the relation to plastic properties is discussed. A.R.Stokes

...2377 RELATIVE POLYGONIZATION RATES IN COPPER AND COPPER—ZINC ALLOYS.
...Heitmann and R.W.Balluffi.
...ppl. Phys. (USA), Vol. 32, No. 5, 963-4 (May, 1961).
Single crystals of Cu, Cu—0.28% Zn and Cu—31% Zn were ...rmed and the rate of polygonization on subsequent annealing measured. The 31% Zn alloy polygonized about 100 times ...er. Simple theories of polygonization dislocation climb and ...ancy diffusion are not in accord with these results.
H.Mykura

12378 CRYSTAL DISTORTION IN COPPER FERRITE—CHROMITE SERIES. H.Ohnishi and T.Teranishi.
Phys. Soc. Japan, Vol. 16, No. 1, 35-43 (Jan., 1961).
The cation distributions in Cu ferrite—chromite series and the ferrite quenched from high temperatures were measured by ...ray diffraction method. The lattice parameters were also ...asured as a function of Cr ion content and of temperature. The ...tical fractions of Cu ions on 16d and 8a sites for the occurrence ...bulk crystal distortion from cubic to tetragonal symmetry are ...ermined. The critical temperature for the distortion of Cu ...rite is 360°C. This crystal distortion depends only upon the Cu ...distribution. The abrupt appearance of distortion and existence of two phases, cubic and tetragonal, near the critical ...action and the critical temperature suggest that this distortion is the first order as predicted by the statistical theory. From the ...eling of the distortion, the activation energy for Cu ion to migrate ...m 16d site to 8a site is obtained. From the comparison of the ...itical fraction of Cu ion in this series with those in other mixed ...nels, the origin of this crystal distortion is discussed.

12379 RESISTIVITY STRIATIONS IN GERMANIUM SINGLE CRYSTALS. H.Ueda.
Phys. Soc. Japan, Vol. 16, No. 1, 61-6 (Jan., 1961).
Resistivity striations resulting from periodic distribution of ...purities were observed in single crystals of Ge grown horizontally. The period of the striations ranges from 0.1 to 0.6 mm, depending upon growth conditions. It is proportional to the average growth rate and inversely proportional to the temperature gradient within the crystal near the solid—liquid interface. This relation can be explained by assuming the supercooled state in the course of Ge crystal growth by the zone levelling technique. By the repeated supercooling and recovery from it, the crystalization proceeds periodically, resulting in the periodic change of the transient growth rate and the periodic segregation of impurities.

12380 PRODUCTION AND MOBILITY OF POINT DEFECTS IN TITANIUM AND ZIRCONIUM.
E. Smith and M.S.Stagg.
Nature (GB), Vol. 189, 300-1 (Jan. 28, 1961).
Some results are presented on the mobility of defects, introduced by low-temperature plastic deformation in titanium and zirconium. Polycrystalline wires of titanium and zirconium were strained at 78°K and their electrical resistivity was measured before and after deformation to ascertain the increase of defects produced. After annealing at room temperature and below, it was found that the extra resistivity introduced by the deformation could be annealed out (though somewhat more slowly in zirconium). It is concluded that there must be an appreciable mobility of defects below room temperature in these materials. This recovery at low temperatures is contrasted to the behaviour of the face-centred cubic metals copper, nickel and gold and it is suggested that interstitials are the primary defects introduced into the hexagonal titanium and zirconium and would be mobile at low temperatures, whereas in the face-centred metals interstitials are not produced. This difference in defect productions is related to the difference in stacking-fault energies between the hexagonal and face-centred metals.
R.Bullough

12381 ACCUMULATIONS OF DISLOCATIONS IN CRYSTALS CONTAINING IMPURITIES.
V.N.Rozhanskii and V.L.Indenbom.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 6, 1331-4 (Feb. 21, 1961).
In Russian.
For abstract, see Abstr. 11200 of 1961. [English translation in: Soviet Physics – Doklady (USA), Vol. 6, No. 2, 101-3 (Aug., 1961)].

12382 A DISLOCATION MODEL OF A TWIN.
A.M.Kosevich and L.A.Pastur.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1290-7 (April, 1961).
In Russian.
Discusses theoretically the equilibrium of a number of continuously distributed twinning dislocations in an isotropic medium. An integral equation governing the equilibrium density of dislocations is derived and investigated; a solution of the equation is obtained in the particular case of pure screw dislocations. The possibility is discussed of determining experimentally the forces resisting motion of dislocations in the crystal. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 935-9 (Oct., 1960)]. R.F.S.Hearmon

12383 DISLOCATION-FREE ALUMINUM CRYSTALS.
S.Howe and C.Elbaum.
J. appl. Phys. (USA), Vol. 32, No. 4, 742 (April, 1961).
Describes the results of X-ray transmission measurements on a conical-shaped crystal grown from the melt (~99.995% pure). The dislocation density was high in the thickest part of the crystal and decreased rapidly with decreasing diameter. It is suggested that the observations are consistent with the idea that collapsing vacancy disks are perhaps the major source of dislocations in crystals grown from the melts of high-purity materials. A.E.Kay

12384 DISLOCATION DECORATION BY PRECIPITATION IN GOLD–COBALT ALLOYS.
R.B.Campbell and L.Muldawer.
Phil. Mag. (GB), Vol. 6, 531-4 (April, 1961).
Precipitation from an alloy of gold + 5 at.% cobalt was observed by electron microscopy using replication and transmission techniques. The precipitate particles form a rectangular grid of lines when observed on {100} faces and mainly parallel lines when observed on {110} faces. The simplest explanation is that dislocations on {110} planes are decorated by cobalt precipitation. These dislocation walls are presumed to have arisen from polygonization during ageing. Geometrical arguments are presented.

12385 LARGE DISLOCATION LOOPS IN ANTIMONY TELLURIDE. P.Delavignette and S.Amelinckx.
Phil. Mag. (GB), Vol. 6, 601-8 (May, 1961).

When slowly grown from the melt, antimony telluride contains large hexagonal loops. The observations suggest that these are prismatic loops resulting from deviations of the stoichiometric composition. In particular it is proposed that tellurium vacancies precipitate in prismatic loops, from which the "geometrical" stacking fault is eliminated, by glide of a partial. An explanation is given for the occurrence of pairs of concentric loops elongated in direction differing by 60°. The equilibrium shape as calculated on the basis of the model agrees reasonably well with the observed shape.

12386 DETERMINATION OF THE DENSITY OF DISLOCATIONS ARISING DURING THE DEFORMATION IN NICKEL, SILVER, ALUMINIUM AND CERTAIN SILVER ALLOYS.
S.D.Hertsriken and N.N.Novýkov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 802-14 (1958).
In Ukrainian.

The number of dislocations was determined which arise as a result of torsion in 99.99% pure Ag, Al, Ni, and in vacuum nickel of 99.5% purity, as well as in certain silver alloys. It was shown that the number of dislocations in the deformed material may increase only up to a definite limit, which differs for different materials. An attempt was made to connect this limiting number of dislocations with the maximum energy stored by the specimen during deformation. The forces are calculated necessary for the breaking of the specimen and it is shown that the calculated values are in good agreement with the experimental results. The minimum possible distance between dislocation centres is shown to differ slightly in various metals, and is equal to 30-40 interatomic distances. The number of dislocations in alloys was found to depend on the nature of the admixture and rises with an increase in the difference of the component radii.

12387 DISLOCATION NETWORKS AND MOIRÉ PATTERNS OF MOLYBDENITE.
Y.Kamiya, K.Ando, M.Nonoyama and R.Uyeda.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2025-35 (Nov., 1960).

In electron micrographs of molybdenite films, various network-patterns were observed. They are interpreted as images of dislocation networks. Several electron micrographs are reproduced and remarkable features observed in them are explained in terms of dislocations. One of the remarkable observations is that each line of a network sometimes becomes broader and the network changes into a moiré pattern. The gradual change from a sharp image of dislocation to a broad moiré fringe can be explained by a simple consideration. The former implies that the strain accompanying the dislocation is concentrated and the latter, that the strain is spread.

12388 OBSERVATION OF LATTICE DEFECTS IN GRAPHITE BY ELECTRON MICROSCOPY. I. F.E.Fujita and K.Izui.
J. Phys. Soc. Japan, Vol. 16, No. 2, 214-27 (Feb., 1961).

Four kinds of dislocations and their combination predicted from the crystal structure were observed through the diffraction contrast and the disturbances in the moiré pattern such as the extra terminating half lines and the line shift. Their network arrangements and movement are also found. The line grating model reveals the relation between the line shift of the moire fringes and the Burgers vector of the glissile dislocations. New origins of extra terminating half lines are considered too.

12389 DIRECT OBSERVATIONS OF ION DAMAGE IN CADMIUM. P.B.Price.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 615-17 (June 1, 1961).

Ion damage in Cd crystals irradiated in an electron microscope is shown to result in nucleation and growth of vacancy-type dislocation loops. R.F.Peart

12390 THE QUESTION OF REVEALING DISLOCATIONS IN GERMANIUM BY ETCHING.
V.M.Vasilevskaya and E.G.Miselyuk.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 429-35 (Feb., 1961).
In Russian.

For abstract, see Abstr. 11214 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 313-21 (Aug., 1961)].

12391 THE FORMATION OF DISLOCATIONS ON ELECT BREAKDOWN IN IONIC CRYSTALS.
M.P.Shaskol'skaya, Van Yan'-vén' [Wang Yen-wên] and Gu Shchu-chzhao'.
Fiz tverdogo Tela (USSR), Vol. 3, No. 2, 658-9 (Feb., 1961).
In Russian.

For abstract, see Abstr. 11215 of 1961. [English transla in Soviet Physics — Solid State (USA), Vol. 3, No. 2, 482-3 (A 1961)].

12392 REVEALING DISLOCATIONS IN CdS SINGLE CRY BY THE ETCHING METHOD.
Zh.G.Pisarenko and M.K.Sheinkman.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1152-7 (April, 1961)
In Russian.

A method of etching CdS crystals in HCl vapour is descri and the connection between the etch pits and dislocations is established. Estimates are given of the dislocation densities the crystals. [English translation in: Soviet Physics — Solid State (USA)]. R.F.S.He

12393 DISLOCATIONS AND FINE LINES IN ROCHELLE CRYSTAL. T.Nakamura and K.Ohi.
J. Phys. Soc. Japan, Vol. 16, No. 2, 209-13 (Feb., 1961).

Etch pits on the c-face of rochelle salt were observed an was concluded that they correspond to points where dislocatio parallel to its c-axis emerge on the c-face. Some of the disl ations were found to be longer than several millimeters. Fin parallel to the c-axis, called "sudaré" among Japanese resea were observed to be distributed in the same manner as disloc etch pits. Sudarés are observed at the deepest points of some pits. If the energy of the interface between the rochelle salt decomposed products are low, the dislocation core may be op and filled with the decomposed products. It seems likely that open-cored dislocation may grow into the sudaré.

12394 DIRECT OBSERVATION OF LATTICE DEFECTS COLD-WORKED HIGH MANGANESE STEELS BY MEANS OF ELECTRON MICROSCOPY.
Z.Nishiyama and K.Simizu.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1963-9 (Nov., 1960).

Thin foils were made by electrolytic polishing from bulk specimens of cold-worked high Mn steel. They were observe electron microscopy with the object of studying lattice defect formed by cold-working. From the micrographs and selected electron diffraction patterns, it is concluded that on {111} pla the austenite matrix very thin (< 100 A) plates of a hexagonal packed phase (ε) are formed, which correspond to the origins strain markings formerly found on the etched surface by usin replica, and that ordinary stacking faults as found in 18-8 sta steels are also present.

12395 AN X-RAY STUDY OF DEFORMATION STACKIN FAULTS AT LOW TEMPERATURES IN LEAD, S LEAD ALLOYS, AND ALUMINIUM.
G.F.Bolling, T.B.Massalski and C.J.McHargue.
Phil. Mag. (GB), Vol. 6, 491-502 (April, 1961).

The deformation stacking-fault probability α, was deter by the deformation of bulk specimens of zone-refined lead at 4.2° and 77°K. Aluminium (99.996%), α-brass (70 : 30), lead–0·1 at.% silver and lead–20·0 at.% indium were also ex at 4.2°K. It is shown that a major difference exists between aluminium and lead, the latter being copper-like in its value The influence of increased deformation in increasing the valu α is demonstrated. Addition of indium to lead suppresses a measurable value of α which correlated with observations m on twinning in this alloy.

Diffusion

12396 THE DISTRIBUTION OF RESIDUAL STRESSES IN PLASTICALLY DEFORMED ROCKSALT CRYSTA
R.I.Garber and L.M.Polyakov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 462-71 (Sept., 1960). In Russian.

Reports the distribution of residual stresses and deform near slip lines. Gives a correlation between residual stress intensity of X-ray scattering and density changes in slip band A.Tybu

97 ROLE OF CRYSTAL STRUCTURE IN DIFFUSION. I. DIFFUSION PATHS IN CLOSEST-PACKED 'ALS. L.V.Azároff.
. Phys. (USA), Vol. 32, No. 9, 1658-62 (Sept., 1961).
consideration of the crystal structures of simple binary com- shows that they can be represented by closest packings of ger anions in which two kinds of interstices are available for ition by the metal atoms. In hexagonal closest packings, the dral voids form continuous chains by sharing opposite faces the tetrahedral voids form isolated pairs. In cubic closest gs, each kind of void shares faces only with unlike voids. The ic diffusion paths available in these compounds depend, there- on the manner in which the voids are occupied. Continuous on paths comprised of normally unoccupied voids exist in nd α-ZnS type structures so that voidal diffusion can take place it requiring defect formation. Similarly, voidal diffusion can in BiO_3, $CrCl_3$, and CdI_2 type structures. Conversely, all ble continuous diffusion paths are blocked by metal atoms in the NaCl, and antifluorite-type structures so that vacancy or inter- cy mechanisms are necessary to account for diffusion.

1398 ROLE OF CRYSTAL STRUCTURE IN DIFFUSION. II. ACTIVATION ENERGIES FOR DIFFUSION IN EST-PACKED STRUCTURES. L.V.Azároff.
l. Phys. (USA), Vol. 32, No. 9, 1663-5 (Sept., 1961).
he effect of available diffusion paths on activation energies onsidered for silver iodide, zinc oxide, and bismuth selenide. hown that the energy in β-AgI should be nearly twice that in because the Ag atoms in tetrahedal sites first must be dis- d to octahedral voids before voidal diffusion can occur in the nodification. The 2 : 1 ratio between the self-diffusion ener- of Zn determined by radioactive tracer and electrical conduct- measurements in ZnO is similarly explained. It is also shown he difference between the activation energies for diffusion in and Bi_2Se_3 can be used to determine the formation energy of cies in BiSe. The agreement between these predictions and imentally determined values attests that qualitatively accurate nations can be based on considerations of the crystal structure.

2399 THE THEORY AND MECHANISM OF DIFFUSION IN SOLIDS. R.A.Lad.
. Today (USA), Vol. 14, No. 5, 42-4 (May, 1961).
A report of a symposium held at Cleveland, Ohio on d 25 October, 1960.

2400 ON THE ENERGY OF THE INTERSTITIAL ATOM IN GRAPHITE. T.Iwata, F.E.Fujita and H.Suzuki.
ys. Soc. Japan, Vol. 16, No. 2, 197-205 (Feb., 1961).
Self- and migration energies associated with interstitial C and toms in graphite are calculated, taking account of the relaxation nd the interstitials. Assuming that the graphite lattice consists in elastic plates held together by the weak interaction forces subjected to the transverse force by the interstitial atom, the n form is obtained by solving the equations for the bending s. Then, employing a suitably chosen interaction potential een the interstitial and all other atoms, the relaxation and the gies associated with the interstitials are calculated. In case of C atom, the self-energy is 2.5 eV, the migration energy 0.016 eV he ratio of strain energy to the total self-energy 0.49, and in of Xe, they are 15.1 eV, 0.03 eV and 0.79 eV respectively.

2401 DIFFUSION OF TIN IN GALLIUM ARSENIDE. B.Goldstein and H.Keller.
pl. Phys. (USA), Vol. 32, No. 6, 1180-1 (June, 1961).
Using radioactive Sn^{113} and the method described earlier tr. 9918 of 1960), the measurements are reported in the erature range 1069° to 1215°C. The diffusion follows the ect solution to the diffusion equation. The observed plot of against 1/T is a straight line and from this plot the values and D_0 in the formula $D = D_0 \exp(-E/kT)$ are 2.5 ± 0.1 eV and 10^{-4} cm^2/sec respectively. Within experimental error, this e of E is the same as that reported earlier (Abstr. 9918 of for the diffusion of cadmium and zinc in gallium arsenide ends support to the idea of sublattice impurity diffusion in ound semiconductors. S.C.Jain

2402 ELECTRON AND X-RAY DIFFRACTION MEASUREMENTS OF THE HETERO-DIFFUSION COEFFICIENTS HE Ni–Cr SYSTEM.
.Pines, I.P.Grebennik and I.V.Smushkov.
Metallov i Metallovedenie (USSR), Vol. 10, No. 6, 879-85 ., 1960). In Russian.
The hetero-diffusion coefficients were measured at 450-900°C. The diffusion activation energy and the multiplier D_0, in $D = D_0 \exp(-Q/kT)$, were obtained as a function of composition. A.Tybulewicz

12403 NEUTRALIZATION OF HYDROXIDE ION IN MELT-GROWN NaCl CRYSTALS. D.A.Otterson.
J. chem. Phys. (USA), Vol. 34, No. 5, 1849 (May, 1961).
NaCl crystals containing 20 p.p.m. of NaOH were heated at 730°C in a slowly moving HCl atmosphere. After treatment for 48 hr. the NaOH concentration was reduced to less than 1 p.p.m. It is suggested that a diffusion mechanism is involved in the neutralization. R.F.Peart

12404 THE PENETRATION OF SILVER INTO AMORPHOUS AND CRYSTALLINE QUARTZ UNDER THE ACTION OF A CONSTANT VOLTAGE. I.E.Balygin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 156-66 (Jan., 1961). In Russian.
The migration of Ag^{110} into quartz is studied by a tracer technique for voltage gradients up to 1.7 kV/mm and temperatures from 400 to 700°C. Photomicrographs are reproduced showing the distribution of the precipitated Ag, and the mechanism of the migration is discussed in relation to the atomic structure of the quartz. [English translation in: Soviet Physics-Solid State (USA), Vol. 3, No. 1, 112-19 July, (1961)]. R.F.S.Hearmon

12405 A HYDROGEN LEAKAGE FILLER. E.T.Kucherenko and O.K.Nazarenko.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 124-5 (Nov. - Dec.). In Russian.
The design of a nickel tube diffusion leak is described for the purification of hydrogen requiring 65 W for a throughput of 200 $cm^3 atm\ hr^{-1}$. Purity was examined with a mass spectrometer. There was no change in O_2 and CO_2 background but some increase in masses 18 (H_2O) and 28 ($N_2 + CO$) amounting to less than 4% attributed partly to sorbed gases released by ion bombardment within the mass spectrometer. [English translation in: Instrum. exper. Tech. (USA), No. 6, 981-2 (Nov. - Dec., 1959; publ. Sept., 1960)]. W.Steckelmacher

Colour Centres

12406 RADIATION INDUCED OPTICAL ABSORPTIONS IN CRYSTALLINE QUARTZ AND FUSED SILICA. K.Kubo.
J. Phys. Soc. Japan, Vol. 16, No. 1, 108-13 (Jan., 1961).
The optical absorption of γ- and fast neutron-irradiated crystalline quartz and fused silica was measured from 186 mμ to 2.6 μ. Dichroism of the A-band was confirmed. The phenomenon of radiation bleaching of the B_1-band and a remarkable movement of the C-band were found. The irradiation and optical bleaching experiments showed that only the C-band is essential due to radiation, and this was considered to be caused by an absorption centre similar to the F-centre which changes F'- or colloidal-centre with subsequent irradiation.

Radiation Effects

12407 FORMATION OF CAVITIES IN SOLIDS AFTER LOCAL MELTING. A.M.Kosevich and L.V.Tanatarov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3012-16 (Dec., 1960). In Russian.
Local melting may be produced in solids by irradiation with sufficiently energetic particles or rays. The authors analyse plastic deformation which occurs on local melting because of different specific volumes of liquid and solid phases. A very large negative pressure in a locally melted region can produce a discontinuity in the liquid phase. This discontinuity is retained as a cavity on solidification. The smallest amount of heat necessary for formation of a cavity is estimated. [English translation in: Soviet Physics – Solid State (USA) Vol. 2, No. 12, 2676-9 (June, 1961)]. A.Tybulewicz

INFLUENCE OF IRRADIATION BY THERMAL NEUTRONS ON THE DIELECTRIC PROPERTIES OF ALKALI-HALIDE CRYSTALS. See Abstr. 12468

STORED ENERGY IN FUEL-BEARING GRAPHITE. See Abstr. 12235

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

12408 A CALCULATION OF THE ELECTRICAL CONDUCTIVITY. N.Matsudaira.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 153-5 (Jan., 1961).

The kinetic theory of Konstantinov and Perel' (Abstr. 4605 of 1961) is applied to the calculation of the static electrical conductivity. Impurity scattering and phonon scattering are considered for the isotropic case. L.Pincherle

12409 THE MATHIESSEN RULE IN DISORDERED BINARY ALLOYS. A.Corciovei and G.Musa.
Acta phys. Polon. (Poland), Vol. 19, No. 6, 647-62 (1960).

The resistivity of a disordered binary alloy is composed of three terms: a vibrational term ρ_v, a disorder (residual) term ρ_d and a mixed term ρ_m. The paper deals particularly with the mixed term, bringing also certain improvements to the terms ρ_v and ρ_d. Finally, ρ_m is compared with ρ_v and ρ_d, and deviation from the Mathiessen rule is discussed.

12410 ELECTRICAL PROPERTIES OF PSEUDO-BINARY SYSTEMS OF $Ag_2VI'S$; $Ag_2Te_xSe_{1-x}$, $Ag_2Te_xS_{1-x}$, AND $Ag_2Se_xS_{1-x}$. S.Miyatani.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1586-95 (Sept., 1960).

The electrical properties such as the electronic and ionic conductivities, Hall coefficients, etc. of the alloys Ag_2 (Te, Se; Te, S; Se, S) were studied with use of the galvanic cell

$$Ag|AgI|specimen|Pt,$$

the excess Ag content being controlled by sending a current across the cell. The electrical properties of these alloy systems change continuously in the α phase as the mixing ratio x is varied, while they change discontinuously or rapidly at certain x's in the β phase. The experimental results are compared with theory under simplifying assumptions such as the energy-independent relaxation time and the energy-momentum relation given by

$$\epsilon = \hbar^2k^2(1 - Bk^2)/2m^*.$$

12411 THEORY OF RESISTANCE MINIMUM IN DILUTE PARAMAGNETIC ALLOYS. K.Tani.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1960-2 (Nov., 1960).

The electrical resistance of dilute paramagnetic alloys was calculated from the standpoint of ascertaining whether the resistance minimum originates from the short range order of the spins of the solute atoms.

12412 CERTAIN ANOMALIES IN THE ELECTRICAL RESISTANCE OF IRON–ALUMINIUM ALLOYS DUE TO THE IRON CORNER. P.V.Petrenko and P.P.Kuz'menko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 820-8 (1958). In Ukrainian.

The authors investigated the dependence of resistance on the temperature and concentration of alloys with concentrations of 16, 20, 25, 30, 35, 40 and 50 atom% of Al in the temperature range 20 - 1200°C and at the temperature of liquid oxygen (for alloys with 40 and 50% of Al).

12413 ELECTRON TRANSPORT AT HIGH TEMPERATURES IN THE PRESENCE OF IMPURITIES.
H.L.Frisch and J.L.Lebowitz.
Phys. Rev. (USA), Vol. 123, No. 5, 1542-9 (Sept. 1, 1961).

The linear transport properties of electrons in a solid are investigated when both phonon and impurity scattering are important The problem is treated for the case where Maxwellian statistics apply and the electrons are described by a classical distribution function in position and velocity, f(r,v). This function satisfies a space-dependent equation in which the interaction with the impurities is treated as part of the Hamiltonian and the phonon scattering is described by a linear Boltzmann-type collision term. This equation is solved formally in the presence of a weak external electric field in a form convenient for perturbation expansions in the relative strength of the different scattering mechanisms, some of which are carried out explicitly. It is also shown rigorously that the change in conductivity due to the presence of impurities is negative.

ELECTRICAL ANOMALIES OF IRON TELLURIDE.
See Abstr. 12531

12414 MEASUREMENT OF MAGNETORESISTANCE IN FERRITES NEAR THE CURIE POINT.
K.P.Belov, A.S.Pakhomov and E.V.Talalaeva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 436-40 (Feb., 1961).
In Russian.

The authors consider the effect of the adiabatic rise of temperature, occurring on application of a magnetic field, on th measured magnetoresistance. A quantitative measure of this e is given for the case of manganese ferrite monocrystals. The authors disprove Zaveta's conclusion (Abstr. 6244 of 1960) that magnetoresistance maximum observed in these monocrystals n the Curie point is due to the magnetocaloric effect. [English t lation in: Soviet Physics—Solid State (USA),Vol. 3, No. 2, 319-2 (Aug., 1961)]. S.Ch

12415 THE TEMPERATURE DEPENDENCE OF MAGNET RESISTANCE OF MANGANESE FERRITES.
E.V.Talalaeva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 441-9 (Feb., 1961).
In Russian.

For abstract, see Abstr. 11264 of 1961. [English translatio in: Soviet Physics — Solid State (USA), Vol. 3, No. 2, 322-7 (Aug., 1961)].

12416 THE LONGITUDINAL MAGNETORESISTANCE OF SEMICONDUCTORS OF THE N-GERMANIUM TYPE THE QUANTUM LIMIT. M.N.Ryabinin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1310-13 (May, 1961).
In Russian.

The elastic scattering of acoustical phonons is taken into account. The results of Argyres and Adams (Abstr. 2195 of 195 are generalized for the case of a quadratic dispersion law. [Eng translation in: Soviet Physics — Solid State (USA)]. K.G.M

12417 CONCENTRATION DEPENDENCE OF THE HALL COEFFICIENT IN THE MAGNESIUM–CADMIUM ALLOYS. S.Noguchi and T.Sato.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1945-9 (Nov., 1960).

The Hall coefficients of Mg–Cd alloys were measured as a function of composition at both room temperature and 300°C wi the magnetic field up to 6.5 KG. For all the compositions, the H coefficients are independent of magnetic field. An electronic structure of this system was discussed with results of the latti spacing relations obtained by Hume–Rothery and Raynor. A re tion between the energy gap and concentration is discussed by comparing their results with the Hall coefficients. The present experimental results indicate that the energy gaps show a tende to increase with the addition of Cd.

12418 HALL EFFECT ON SOME OF THE MAGNETIC COMPOUNDS.
S.Fujime, M.Murakami and E.Hirahara.
J.Phys. Soc. Japan, Vol. 16, No. 2, 183-6 (Feb., 1961).

A sensitive Hall measuring apparatus was constructed, and making use of it some magnetic compounds, nickel oxide, iron telluride, nickel telluride, and iron sulphide were studied. Iron sulphide was studied because of the interest in its remarkable anisotropies of conductivity and susceptibility. From the result one may say that the anisotropy of conduction is responsible fo the anisotropy of its mobility but not for the carrier concentrati

12419 GALVANOMAGNETIC MEASUREMENTS IN HIGHLY CONDUCTING SEMICONDUCTORS.
S.W.Kurnick and R.L.Fitzpatrick.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 452-3 (April, 1961).

Describes an a.c. method using a magnetron magnet (4600 gauss) of measuring Hall voltage (sensitivity ~ 1×10^{-9}V) and conductivity of semiconductors such as Ge for Esaki diodes (carrier concentration ~ 1.4×10^{19} cm^{-3}) and $CeS_{1/4}$ for thermo electric applications (carrier concentration 6.0×10^{21} cm^{-3}). The method is shown to be applicable where a d.c. method with a magnetic field of 10 000 gauss fails. G.C.Will

12420 ELECTRICAL CONDUCTIVITY OF SOLIDS WITH IONIC–HOMOPOLAR VALENCE. X. ELECTRICAL CONDUCTIVITY OF GLASSES CONTAINING TWO TYPES OF ALKALI IONS. R.L.Myuller.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 6, 1339-44 (June, 1960).
In Russian.

For Pt IX see Abstr. 17981 of 1960. Critical analysis of

121 ELECTRICAL CONDUCTIVITY OF SOLIDS WITH IONIC-HOMOPOLAR VALENCE. XI. DEGREE OF CIATION AND MOBILITY OF CATIONS IN GLASSES AINING TWO TYPES OF IONS. R.L.Myuller. verdogo Tela (USSR), Vol. 2, No. 6, 1345-52 (June, 1960). ssian.

The equations are derived for the molar electrical conductivity asses containing two types of univalent cations. Experimental confirm the absence of space-mechanical hindrances to the ment of cations, and indicate the existence of entropy effects conductivity of complex borate and silicate glasses. In e glasses containing silver and thallium ions, the mutual gement of the polar structural nodes leads to their displace- and to the disappearance of the minimum effect in conductivity previous abstract). [English translation in: Soviet Physics- State (USA), Vol. 2, No. 6, 1224-30 (Dec., 1960)].

R.F.S.Hearmon

2422 TEMPERATURE DEPENDENCE OF CONDUCTIVITY OF LAYERS OF LEAD SULPHIDE AT THE FREQUENCY 10^{10} c/s. V.G.Erofeichev and L.N.Kurbatov. tverdogo Tela (USSR), Vol. 3, No. 2, 595-8 (Feb., 1961). ussian.

For abstract, see Abstr. 11269 of 1961. [English translation Soviet Physics — Solid State (USA), Vol. 3, No. 2, 436-8 II, 1961)].

2423 ELECTRICAL CONDUCTION IN POLYCRYSTALLINE LEAD ZIRCONATE-TITANATE. Stephenson and C.E.Flanagan. hem. Phys. (USA), Vol. 34, No. 6, 2203-4 (June, 1961).

The authors studied the anomalous pyroelectric effect in this erial and shown that it is probably an ionic conductor (the c conduction is possibly the cause of the anomalous behaviour). experiments involved measurement of the e.m.f. of a Pt/Pb,)/$PbZr_{0.53}Ti_{0.47}O_3$/Cu, Cu_2O/Pt cell, which was found to be 05 V at 250°C in agreement with a theoretical value. An oxygen- rogen fuel cell was used to indicate that conduction is due in t to oxygen ion migration. I.Cooke

12424 ANISOTROPY OF ELECTRICAL CONDUCTION IN IRON SULFIDE SINGLE CRYSTAL. M.Murakami. Phys. Soc. Japan, Vol. 16, No. 2, 187-92 (Feb., 1961).

To investigate the anisotropy of the conductivity of a FeS single stal, a simultaneous measurement of the conductivity and the rmal expansion was carried out. The result is that the conduct- ty is intimately correlated with the lattice parameter (or exchange rgy), but is not necessarily affected by the spin direction. From s result, a spin sublattice structure of high temperature type is posed, and the anisotropy of the conductivity in the range of nperature near the α-transformation temperature is interpreted alitatively.

12425 ELECTRIC CONDUCTION OF FERRITES CONTAINING Fe^{2+}-IONS. N.Miyata. Phys. Soc. Japan, Vol. 16, No. 2, 206-8 (Feb., 1961).

The d.c. electric conductivity was measured between 100° and 0°K for the ferrite solid solution $(MeFe_2O_4)_{1-y}(Fe_3O_4)_y$, where e = Mn, Ni, Mn—Ni or Zn. Above 120°K the specific conductivity each specimen depends on temperature as $\sigma = A\cdot\exp(-\epsilon/kT)/T$. e activation energy ϵ is $(5 \sim 8) \times 10^{-2}$ eV. A depends on the ncentration, y, of Fe_3O_4 as $A = (6.5 \pm 2.5) \times 10^4(y/1-y)$ g Ω^{-1} cm^{-1}. The analysis of these experimental expressions ows that the dependence of the mobility on temperature for each ecimen can be fitted by the expression, $\mu = \mu_0\cdot\exp(-\epsilon/kT)/T$ d the dependence on the Fe^{2+}-ion concentration, y, by $= (3.0 \pm 1.2) \times 10^4(1/1-y)$ deg (cm^2 V^{-1} sec^{-1}). μ_0 is indepen- nt of the kind and distribution of Me^{2+}-ions.

12426 HIGH ELECTRIC FIELDS IN CADMIUM SULFIDE: FIELD-EFFECT CONSTRICTION OF CURRENT FLOW ND DIELECTRIC BREAKDOWN. R.Williams. ys. Rev. (USA), Vol. 123, No. 5, 1645-51 (Sept. 1, 1961).

Field-effect measurements were employed to study constriction current flow in very thin single crystals of conducting CdS. With ectrical conductivity data for complex glasses shows that the ntent of conducting ions must be related to unit volume; if pressed in weight or molar percentages, erroneous electro- emical conclusions are drawn. The existance of a minimum in e conductivity—concentration curve is explained in terms of lar nodes, differentiated by the type of ion. [English translation : Soviet Physics-Solid State (USA), Vol. 2, No. 6, 1219-23 ec., 1960)].

R.F.S.Hearmon

an electrolyte field electrode and crystals having about 1 ohm cm resistivity, it was possible to obtain complete pinch-off of current flow through the crystal by applying voltage to the field electrode. The technique used is evaluated quantitatively and is found to be a satisfactory method for obtaining high electric fields of known magnitude in CdS. Dielectric breakdown occurs when sufficiently high voltage is applied to the field electrode. The breakdown field strength was found to be 1.8×10^6 V cm^{-1} at 25° C.

Semiconductors

12427 THE CHEMICAL POTENTIAL AND THE CRITERION OF DEGENERACY OF CONDUCTION ELECTRONS IN A STRONG MAGNETIC FIELD. A.I.Ansel'm and B.M.Askerov. Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2821-6 (Nov., 1960). In Russian.

The chemical potential of conduction electrons in a magnetic field is calculated in the quantum limit. Cases of degeneratr, non-degenerate and intermediate electron states are discussed. The dependence of the electron density on magnetic field is found at various temperatures for the case of monovalent donor impurities. [English translation in: Soviet Physics—Solid State (USA), Vol. 2, No. 11, 2512-16 (May, 1961)]. A.Tybulewicz

12428 THE DISTRIBUTION OF NON-EQUILIBRIUM CARRIERS IN THE SURFACE LAYER OF THE SPACE CHARGE IN SEMICONDUCTORS AT HIGH SURFACE POTENTIALS. Yu.A.Kurskii. Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 212-13 (Jan., 1961). In Russian.

A discussion of the possible reasons for the departure of the distribution function of carriers from the Maxwell—Boltzmann equation, with special reference to the effects of generation and recombination of excess carriers. See also Abstr. 2305 of 1958. [English translation in: Soviet Physics-Solid State (USA), Vol. 3, No. 1, 154-5 (July, 1961)]. R.F.S.Hearmon

12429 THE SCATTERING OF PHONONS BY BOUND ELECTRONS IN A SEMICONDUCTOR. I.C.Pyle. Phil. Mag. (GB), Vol. 6, 609-16 (May, 1961).

In a fairly pure semiconductor at low temperatures, the carriers are in states bound to impurity atoms. In compensated material, there will be some bound states which are not occupied. A carrier can jump from one impurity state to an unoccupied neighbour, and thereby interact with lattice waves, setting up a thermal resistance. The effective mean free path of phonons affected by this mechanism is calculated. This mean free path varies inversely as the number of carriers and the number of vacancies, and as a function of temperature has a minimum, at about 0.2°K for "light" holes in germanium. Some phenomena in the thermal conductivity of germanium are thought to be due to this effect.

12430 DESCRIPTION OF IMPURITY IONIZATION IN SEMICONDUCTORS BY CHEMICAL THERMODYNAMICS. W.W.Harvey. Phys. Rev. (USA), Vol. 123, No. 5, 1666-73 (Sept. 1, 1961).

The phenomenon of impurity ionization is considered on the basis of exact thermodynamics, involving an extension of the usual mass-action formalism. To make possible the evaluation of quantities of interest in the two-band model of covalent semiconductors, comparison is made with the statistical formulation of ionization equilibrium. Particular consideration is given to the concentration dependence of the impurity ionization energy. Interactions betwen ionized impurities and mobile carriers are treated by the Debye—Huckel theory of strong electrolytes; the treatment involves only one parameter which must be determined from experimental carrier densities. Very good agreement is found for arsenic-doped germanium using the detailed data and analysis of Debye and Conwell (1954).

12431 THE FARADAY EFFECT IN NON-DEGENERATE SEMICONDUCTORS. B.Donovan and J.Webster. Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 120-32 (July, 1961).

The theory of the Faraday effect, due to free charge carriers, is developed for non-degenerate semiconductors with spherical energy surfaces. General expressions for the Faraday rotation θ and the ellipticity δ are given, which are valid for all frequencies from the microwave region to the infrared, and for all magnetic field strengths within the limitations of the Boltzmann equation. The cases of lattice scattering and impurity scattering are considered separately and the numerical calculations are based on

experimental data for n-type germanium. The rotation θ changes sign at the cyclotron resonance frequency in strong fields and at a lower frequency (determined by the relaxation time) in weak fields. The ellipticity δ passes through zero at a frequency corresponding to maximum θ, and reaches a maximum when θ is zero. In the limit of high frequencies and weak fields θ (but not δ) is independent of the relaxation mechanism. Both θ and δ vary linearly with field strength in weak fields but subsequently pass through a maximum. The temperature dependence of θ and δ is examined in the range 100-300°K for lattice scattering and 15-100°K for impurity scattering. As the temperature is lowered, in general θ and δ both increase in the case of lattice scattering, and both decrease in the case of impurity scattering.

IMPURITY PHOTOCONDUCTIVITY IN SEMICONDUCTORS.
See Abstr. 12356

Semiconducting Materials

12432 ELECTRONIC PROCESSES AT INTERCRYSTALLINE BARRIERS IN GERMANIUM. T.Figielski.
Acta phys. Polon. (Poland), Vol. 19, No. 6, 607-30 (1960).

The effect of grain boundaries (GB) in n-type Ge on hole diffusion, GB-photoelectric phenomena and transients was investigated. Boundaries of two kinds were found to exist. GB of the first kind are characterized by enhanced hole recombination and the absence of photoelectric phenomena. GB of the second kind revealed no recombinative action and, moreover, the diffusion length of holes as measured in the plane of lineage were usually considerably in excess of the volume diffusion values. Such GB were the site of intense photoelectric effects. The conclusion is reached that a n–p+–n structure (corresponding to high potential barriers) is formed on GB of the second kind, and that their properties are determined by a specific "feed-in, feed-out" effect. GB of the first kind may be considered to correspond to n–p–n structures, or to dislocation lineage.

12433 THE STEADY-STATE CONCENTRATION OF THERMAL ACCEPTORS IN GERMANIUM AFTER VARIOUS HEAT TREATMENTS. V.A.Zhidkov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 459-63 (Feb., 1961). In Russian.

The temperature dependence of the steady-state thermal acceptor concentration was found for Ge of various purities. The results are explained on the assumption of two states of copper in the Ge lattice. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2, 335-8 (Aug., 1961)]. S.Chomet

12434 THERMAL ACCEPTORS WITH HIGH ENERGY LEVELS IN GERMANIUM. V.A.Zhidkov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 464-75 (Feb., 1961). In Russian.

The author found the conditions of formation and the temperature dependence of the steady-state concentration of thermal acceptors with an activation energy of 0.25 eV. Annealing at low temperatures and its effects were explained by assuming two types of thermal acceptors in Ge. The energy structure of defects with properties of thermal acceptors is discussed. It is suggested that thermal acceptors with high activation energies are copper atoms in special energy states. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2, 339-47 (Aug., 1961)]. S.Chomet

12435 AN EXPERIMENTAL STUDY OF THE VOLUME GRADIENT E.M.F. APPEARING IN GERMANIUM IN THE PRESENCE OF A CURRENT.
P.I.Baranskii, G.M. Dzyubenko and N.S.Konoplyasova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 876-83 (March, 1961). In Russian.

In n-type Ge it was shown that the e.m.f. is related to the effective lifetime of minority carriers and both are reduced by the same factors. The temperature dependence of the e.m.f. is correlated with that of the ratio of holes to electrons. The current dependence was also studied. It is concluded that the volume-gradient e.m.f. is due to the effect of a distributed injection of minority carriers which occurs within the Ge volume when there is a gradient of specific resistivity. [English translation in: Soviet Physics–Solid State (USA)]. R.Berman

12436 ANISOTROPIC HALL COEFFICIENTS IN N-TYPE GERMANIUM. H.Miyazawa and H.Maeda.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1924-9 (Nov., 1960).

Precise measurements of the Hall effect were made at 77°K, 90°K, 195°K, and 298°K up to 11 000 gauss on oriented single crystals of n-type Ge containing 5×10^{14} Sb per cm³ as donor. The results should principally indicate the variations of μ_H/μ with the magnetic field and with the temperature, since the carrier concentration may be practically constant under the present conditions. Absolute values of μ_H/μ were deduced from R_∞ and R_∞, for which μ_H/μ always equals unity, is obtained by extrapolating $R_H^{\langle 001\rangle}$ (77°K) versus $1/H^2$. Then $R_H^{\langle 001\rangle}/R_\infty$ gives μ_H/μ ($\langle 001\rangle_H$). On the other hand, μ_H/μ for other orientations may be indirectly estimated from their extraporated R_o, for which μ_H/μ is independent of the orientation and should be equal to $R_o^{\langle 001\rangle}/R_\infty$ at respective temperatures, neglecting the effect due to slightly different impurity concentration between specimens. Values of μ_H/μ thus determined are always less than unity, while those of $\langle 001\rangle_H$ approach unity most rapidly and those of $\langle 110\rangle_H$ most slowly with increasing field. They are of course temperature dependent and the zero magnetic field values are equal to 0.83 at 77°K, 0.84 at 90°K, 0.90 at 195°K and 0.92 at 298°K respectively. Numerical evaluation of the Boltzmann equation taking account of ellipsoid model and mixed scatterings can give the observed values fairly well. It appears however, preferable to introduce some correction term, e.g., reasonable amount of optical phonon scattering for the best agreement.

12437 ON RECOMBINATION PROCESSES IN NEUTRON-IRRADIATED n-TYPE GERMANIUM.
M.Bertolotti and D.Sette.
Nuovo Cimento (Italy), Vol. 20, No. 3, 438-42 (May 1, 1961).

A calculation of minority charge-carrier lifetime in neutron-irradiated n-type germanium is performed taking into account the presence of damage regions produced by fast secondaries. The results are compared with experimental data.

12438 ENERGETIC DISTRIBUTION OF ELECTRON STATES ON A GERMANIUM SURFACE. N.S.Chorna.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 751-64 (1958). In Ukrainian.

Studied on a p-type gallium-alloyed germanium surface etched in H_2O_2 (ρ = 25 ohm cm). The method is based on the theory of thermal equilibrium at the surface and internal levels of a semiconductor. It consists essentially in the comprehensive study of the temperature dependence of values characterizing the field effect, the modulation attenuation factor η and the conductivity change effect under the influence of an external (transverse) electric field γ. The measurements were carried out in an ultrahigh vacuum ($\sim 1 - 2 \times 10^{-9}$ mm Hg). The experimental results indicate that in the investigated interval of the forbidden band there exists one acceptor [$N_a = (8 \pm 1) \times 10^{12}$ cm^{-2}, $E_a = 0.30 \pm 0.02$ eV] ; and donor surface level [$N_d = (1.3 \pm 0.2) \times 10^{12}$ cm^{-2}, $E_d = (0.14 \pm$ eV] . With a change in W_o, there is a change in the surface level distribution with respect to the E_F level. The effectiveness of a given surface level is due to this. In the temperature interval $243°K < T < 267°K$ the modulation attenuation factor η is large and two types of level are observed: a donor and an acceptor. At temperatures below 240°K, η is small,and only one type of level (the donor) is noted. These facts agree with the theoretical ideas.

12439 THE ROLE OF THE DIELECTRIC IN INVESTIGATING THE EFFECT OF THE FIELD IN SEMICONDUCTORS
V.E.Primachenko and O.V.Snitko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 15-18 (Jan., 1961). In Russian.

Experiments were carried out on capacitors formed with facings of semiconducting materials (n– and p-type Ge and n-type Si), with and without mica as the dielectric, under vacuum conditions, and in air of different humidities. The photo-e.m.f. and the change in surface conductivity of the semiconductor were measured when an external electric field was applied to the capacitor. Relaxation effects in the conductivity were also measured. The results are discussed in relation to the transfer of charges in the semiconductor to the dielectric under the various conditions of the experiments. See also Abstr. 5647 of 1959. [English translation in: Soviet Physics – Solid State (USA), Vol. 3, No. 9-12 (July, 1961)]. R.F.S.Hearn

12440 HEAT TREATMENT CENTERS IN SILICON. Y.Matukura.
J. Phys. Soc. Japan, Vol. 16, No. 2, 192-7 (Feb., 1961).

Heat treatment of p-type Si at temperatures above 900° C

iently results in a decrease of hole concentration. In the present riments, heat treatment centres were found to diffuse from the ace during such heat treatment, in the case of a sufficient con- ration to account for the observed changes in the electrical acteristics. The heat treatment centre has a deep donor level 4 eV above the valence band. This level is converted into a r level 0.51 eV from the conduction band at room temperature. treatment centres may perhaps be introduced into Si by surface rity. Diffusion of the surface impurity is classified by its d into two species. The faster diffusion one is characterized e diffusion coefficient of 1×10^{-6} cm^2 sec^{-1} at 1017° C and the vation energy for the solution, 1.8 eV. Observed properties on eat treatment centre show that heat treatment in the temper- e range 900° to 1265° C results in diffusion of Fe from the ace into bulk material.

12441 VALENCE SPIN–ORBIT SPLITTING AND CONDUCTION g TENSOR IN Si. L.Liu.
s. Rev. Letters (USA), Vol. 6, No. 12, 683-5 (June 15, 1961).
Reasons are given for the inadequacy of the previously used two- d approximation for calculating the conduction g-tensor in Si. spin–orbit operator is here calculated from OPW wave-functions states along the (1,0,0)-direction in k-space and the g-shift is ived from it. The values obtained both for the spin–orbit split- ; at k = 0 and the shifts $\delta g_{\parallel}$ and $\delta g_{\perp}$ are in good agreement with erimental data. L.Pincherle

12442 INVESTIGATION OF THE HOLE SPECTRUM OF Bi_2Te_3. E.K.Kudinov.
tverdogo Tela (USSR), Vol. 3, No. 2, 317-25 (Feb., 1961).
ussian.
The form of the energy spectrum of the holes in bismuth uride is determined. The results coincide with the empirical ues obtained by Drabble (Abstr. 302 of 1959) [English translation Soviet Physics–Solid State (USA), Vol. 3, No. 2, 227-33 g., 1961)]. N.Davy

12443 ON A GROUP OF TERNARY SEMICONDUCTING COMPOUNDS. L.S.Palatnik, Yu.F.Komnik, M.Koshkin and E.K.Belova.
Akad. Nauk SSSR, Vol. 137, No. 1, 68-71 (March 1, 1961).
Russian.
A group of ternary compounds $B^{II}B^{IV}B^{VI}_2$, where B^{II}–Cu. –Ge, Sn, Pb; B^{IV}–S, Se, Te, have been synthesized by fusion. all cases, except that of fusion with lead, the materials have a mond lattice structure. The lattice structure has been examined the materials and values of the lattice parameter "a" and ionic radii are given for the various compounds. [English translation in: viet Physics–Doklady (USA), Vol. 6, No. 3, 241-3 (Sept., 1961)]. K.N.R.Taylor

12444 ON THE MECHANISM OF THE ELECTRICAL CONDUCTION IN CdSe.
Tubota, H.Suzuki and K.Hirakawa.
Phys. Soc. Japan, Vol. 15, No. 9, 1701 (Sept., 1960).
Various elements (Cu, Ag, Cd, In, Sn, Pb, Se) were evaporated to the surface of single crystals of n-type CdSe, and the crystals re heat-treated at various temperatures for various durations so t diffusion occurred. The room-temperature resistivity was asured as a function of the duration of heat treatment at 350° C r all specimens) and at 140° C and 550° C (Cd-doped specimens y). It is concluded that the impurity centres contributing to nduction in CdSe may be Se vacancies, and the results are cussed in terms of the atomic radii of the doping elements. J.B.Birks

12445 ON THE ELECTRICAL AND OPTICAL PROPERTIES OF P-TYPE CADMIUM TELLURIDE CRYSTALS.
Yamada.
Phys. Soc. Japan, Vol. 15, No. 11, 1940-4 (Nov., 1960).
The properties were measured with p-type synthetic CdTe gle crystals. The Hall coefficients of the crystals increased by heat treatment or the growth in the cadmium vapour. It is own that the intrinsic energy gap is about 1.43 eV, the ionization ergy of acceptors is about 0.20 eV and the Hall mobility of holes about 80 cm^2/V sec at room temperature. The data of Hall bilities are in agreement with the theory of interaction with the tical mode of lattice vibrations.

12446 PROPERTIES OF HIGH-RESISTIVITY GALLIUM ARSENIDE COMPENSATED WITH DIFFUSED COPPER.
J.Blanc, R.H.Bube and H.E.MacDonald.
J. appl. Phys. (USA), Vol. 32, No. 9, 1666-79 (Sept., 1961).
Low-resistivity n-type GaAs crystals with silicon donors are compensated with diffused copper to produce high-resistivity crystals in a manner which is amenable to semiquantitative description in terms of a simple thermodynamic model. The high-resistivity GaAs:Cu crystals are subjected to photoelectronic analysis, including room temperature Hall and photo-Hall measurements, to obtain information about the effects of deep-lying imperfections on the properties of the initial n-type GaAs. In addition to three deep donors previously reported, five acceptors are revealed. A 0.42 eV acceptor level, when compensated, provides a long electron lifetime resulting in high n-type photosensitivity at low temperatures. Evidence for effects on the electron mobility is obtained for compensated deep donor levels, important mainly in high-resistivity n-type material, and for compensated acceptors lying 0.22 eV above the valence band, important mainly at low temperatures.

12447 CARRIER DENSITIES AND MOBILITIES IN PYROLYTIC GRAPHITE. C.A.Klein and W.D.Straub.
Phys. Rev. (USA), Vol. 123, No. 5, 1581-3 (Sept. 1, 1961).
Based on conductivity, Hall effect, and magnetoresistance measurements, an attempt is made to describe the behaviour of current carriers in the layer planes of well-ordered pyrolytic graphite. The total carrier concentration decreases from approximately 11×10^{18} cm^{-3} at room temperature to less than 4×10^{18}cm^{-3} at very low temperatures, in good agreement with single-crystal results. The average mobility, which is strongly dependent upon the crystallite size, was found to exceed 3000 cm^2 V^{-1} sec^{-1} at liquid nitrogen temperature in specimens deposited at 2500° C; the mobility ratio (μ_e/μ_h) appears to remain temperature independent and equal to 1.08 ± 0.01.

12448 THE TEMPERATURE DEPENDENCE OF THE CHEMICAL POTENTIAL OF A SEMICONDUCTOR.
S.M.Chanyshev and V.É.Zgaevskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2461-2 (Oct., 1960).
In Russian.
Shows that above 300° K one must allow for the temperature dependence of the forbidden band width in plotting the temperature dependence of the chemical potential, $\mu^*(T)$, of InSb layers. [English translation in: Soviet Physics–Solid State (USA), Vol. 2, No. 10, 2193 (April, 1961)]. A.Tybulewicz

OBSERVATIONS OF DE HAAS–VAN ALPHEN OSCILLATIONS IN P-TYPE PbTe. See Abstr. 12516

Semiconductor Devices

12449 THE THEORY OF THE DEGENERATE p–n JUNCTION.
I.I.Ivanchik.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 103-18 (Jan., 1961).
In Russian.
An idealised Esaki ("tunnel") diode is considered, having a sharp junction between degenerate p- and n-type material. The charge distribution is obtained by the Thomas - Fermi method, and a tunnelling probability is derived for the special case of equal hole and electron masses. This is used to find the current–voltage characteristic (in particular its peak value) in the two limiting cases of long and short mean free paths for the carrier gas. These results are compared with the published data (Abstr. 2314 of 1958; 13628 of 1960). [English translation in: Soviet Physics-Solid State (USA), Vol. 3, No. 1, 75-84 (July, 1961)]. I.D.C.Gurney

12450 EFFECT OF TRAPPING LEVELS ON THE DECAY OF THE n–p JUNCTION CURRENT.
F.M.Berkovskii, S.M.Ryvkin and N.B.Strokan.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 230-5 (Jan., 1961).
In Russian.
In an illuminated photodiode generated electron–hole pairs diffuse towards the n–p boundary, are separated by the contact potential and produce a current in the external circuit. Trapped holes do not contribute to the latter, and observation of typical "tails" in decay current characteristics of germanium photodiodes operated under −80° C should be possible. An experimental set-up is described, submitting the diode to chopped light and observing photoconductivity and short-circuit photocurrent by oscillograph. Typical curves, taken at the temperature of liquid

nitrogen, show rapid and slow zones of decay, the latter being associated with trapping. Multiple trapping, of the so-called α-type, arises at levels where the concentration of free minority carriers changes under conditions of intense thermal reaction; single trapping (β-type) appears with fast decay characteristics and practically does not affect the decay itself. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 169-72 (July, 1961)]. A.Landmar

12451 THE LINEAR PART OF THE VOLT-AMPERE CHARACTERISTIC OF AN ASYMMETRICAL DIODE.
V.I.Stafeev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 185-93 (Jan., 1961).
In Russian.

Formulae for I_p and I_n are derived, discussed, and shown not to affect the carrier distribution in a practical asymmetrical diode. It is then shown that the charge injection in the low resistivity region can be neglected, thus leading to simplified formulae for the potential drop across the semiconductor junction. It is proved that under conditions of high re-combination velocities within the space charge region, negative resistance characteristics can arise, and that at high injection levels a minimum barrier potential is obtained, corresponding to a maximum concentration of injected carriers. In this region the diode resistance no longer depends on the current. Analytical expressions for the turn-over voltage and its dependance on temperature are then derived. A brief account of experimental checks shows good agreement with theory. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 135-40 (July, 1961)]. A.Landman

12452 PLANAR ALLOY GaAs DIODES.
Yu.M.Burdukov, A.N.Imenkov, D.N.Nasledov and B.V.Tsarenkov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 991-4 (March, 1961).
In Russian.

The volt–ampere characteristics are shown for temperatures of 25 and 300° C and discussed in relation to the present theory. The existence of an inversion layer is proposed. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 3, 721-3 (Sept., 1961)]. D.J.Huntley

12453 DIRECT VIEWING OF IMPERFECTIONS IN GERMANIUM P–N JUNCTION. M.Tomono.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2254-64 (Dec., 1960).

A p–n junction was made by alloying In on an n-type Ge pellet and it was put into an electrolyte solution of copper salt. When suitable reverse voltage was applied on the junction by a charged condenser, a copper shaded pattern was deposited on the opposite side of the alloyed surface in accordance with the density of the reverse current flowing through every part of the p–n junction. By this method, the breakdown at the imperfections of p–n junction due to the defects in the Ge crystal, those at the periphery of p-type recrystallized layer, and those inside p–n junction grown in alloying process were observed. Then, the cross-section was made referring to the pattern, and several kinds of the imperfections of p–n junction were observed under a microscope.

12454 ELECTRONIC PROCESSES AND EXCESS CURRENTS IN GOLD-DOPED NARROW SILICON JUNCTIONS.
C.T.Sah.
Phys. Rev. (USA), Vol. 123, No. 5, 1594-1612 (Sept. 1, 1961).

Large amounts of excess current in gold-doped silicon tunnel junctions are observed and interpreted as due to transition processes with the two gold energy levels in the forbidden gap of silicon as intermediate states. Eigth of the ten possible processes are two-step processes. These two steps may be both of the Hall–Shockley–Read type or of the type involving electron tunnelling between a trap state and a band state within the space charge region of the junction. The two steps may also consist of a Hall–Shockley–Read process as one step, and the tunnelling from or to the trap state as the other step. One of the remaining two possible processes is a three-step process involving two Hall–Shockley–Read steps and one tunnelling step between two trap states within the space-charge region. The last process is the usual carrier injection process. Eight of the ten processes in the gold-doped tunnel diodes have appreciable transition rates. Five of the eight processes have onset structures which appear at voltages in reasonable agreement with the predicted values. Approximate theoretical current–voltage expressions are compared with experimental data of the gold-induced excess current at 4.2° K, giving an average value of $W^2 m_t / m \approx 1.2 \times 10^{-33}\ V^2\ cm^2$, where W is Price's matrix element of the trap potential energy in excess of the crystal potential taken between the unnormalized trap-state wave-function and the ba edge Bloch wave-function, normalized to unit volume, and m_t the transverse electron mass normalized to the free electron It is also experimentally determined that the rate of tunnelling or to trap state is smaller than the rate of filling or emptying trap in the Hall–Shockley–Read process.

12455 DETECTION OF MILLIMETRE AND SUB-MILLIM WAVE RADIATION BY FREE CARRIER ABSORPT IN A SEMICONDUCTOR. B.V.Rollin.
Proc. Phys. Soc. (GB), Vol. 77, Pt 5, 1102-3 (May, 1961).

A method is proposed for detecting radiation of millimetr and sub-millimetre wavelengths by use of the energy depender of the mobilities of carriers in semiconductors and the consec change in conductivity accompanying free carrier absorption. urements on a sample of indium antimonide at 2° K led to an estimated sensitivity of $2.4 \times 10^{-3}\ v/w^{-1}$. It is suggested that t sensitivity could be increased by the use of cyclotron resonanc absorption, a resonant cavity, or by operation as a mixer.

Photoconductivity

12456 INVESTIGATION OF THE KINETICS OF IMPURIT PHOTOCONDUCTIVITY AS A METHOD OF DETEF MINING THE PARAMETERS OF LOCAL LEVELS.
S.M.Ryvkin, L.G.Paritskii, R.Yu.Khansevarov and I.D.Yaroshe
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 252-66 (Jan., 1961).
In Russian.

Deals with an impurity semiconductor. Theoretical predic are made for the variation of current with intensity of illumina and for the variation of the number of photocarriers (due to a pulse of light) with time. Predictions are made of the form of time constants of growth and decay of the impurity photocurrer In this way it should be possible to determine such parameters the concentration of impurity centres and the cross-section fo capture of a photon. The properties of simultaneously stimula impurity and intrinsic photocurrents are also considered. [English translation in: Soviet Physics – Solid State (USA), Vol No. 1, 185-94 (July, 1961)]. K.G.

12457 THE SPECTRAL DISTRIBUTION OF PHOTOELEC SENSITIVITY OF CRYSTALS OF Cu_2O AT LOW TEMPERATURES. I.Pastrnyak and R.A.Titov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 861-8 (March, 1961).
In Russian.

A correlation between the structure of the optical absorpti and reflection at the absorption edge, and the spectral distribut of photosensitivity was found at low temperatures. It is shown excitons take part in the photoeffects in a narrow spectral regi corresponding to their role in absorption. Attention is drawn t effect of the applied voltage and the geometry of the illuminati relative to the electrodes, on the measurement of the low temp ture photoeffects. Their effect on both the magnitude and decay the photocurrent was examined. [English translation in Soviet Physics – Solid State (USA), Vol. 3, No. 3, 627-32 (Sept., 1961) K.N.R.T

12458 EFFECT OF OXYGEN UPON SINTERED CADMIU SULPHIDE PHOTOCONDUCTING FILMS. S.Kitan
J. Phys. Soc. Japan, Vol. 15, No. 12, 2343-50 (Dec., 1960).
The dark conductivity and decay time of sintered CdS films pr by firing in N gas were higher than those of sintered CdS films prepared by firing in the mixture of N gas and H_2S. According was thought that the sintered CdS films prepared by firing in N have many S vacancies acting as donors. As a result of heat-treatment in O of the sintered CdS films prepared by firing in N gas, the dark conductivity and decay time decreased. A new appeared at 680 mμ in spectral response of the photocurrent. activation energy obtained by measuring the slope of the curve logarithm of dark conductivity plotted against 1/T (°K) increas while the trap concentration obtained by measuring the therma stimulated current decreased with the increase in temperature heat-treatment in O. The results of experiments supported the interpretation that S vacancies acting as donors had been occu by O atoms, and then vanished. At the same time there were p duced new exciting centres at about 1.8 eV below the bottom of conduction band. By electron-microscopic observations it was found that by heat treatment above 400° C in oxygen, CdO grain

roduced on the surface or near the grain boundary of the d CdS film, and when the whole surface of the CdS film was by CdO layers, photoconductivity was not observed.

459 EFFECT OF ANNEALING AND OF CERTAIN IMPURITIES ON THE DARK RESISTANCE AND PHOTOSENSITY OF SINGLE CRYSTAL CdS.
rofimenko and H.A.Fedorus.
n fiz. Zh. (USSR), Vol. 3, No.6, 839-41 (1958). In Ukrainian.
nealing took place at 700-750°C in various atmospheres H_2, $H_2S + H_2$, A and vacuum. The dark resistance was higher annealing in H_2S ($10^{11} - 3 \times 10^{12}$ ohms); the photosensitivreased by several factors of ten after treatment in H_2. Dopth Al, In, Ag, Cu, Au varied the dark resistance and photoivity over wide ranges (several powers of 10).

2460 THE LIMITED USEFULNESS OF THE IDEA OF A UNIVERSAL CONSTANT OF SURFACE RECOMBINA- IN AN INVESTIGATION OF THE KINETICS OF PHOTOELEC- PROCESSES. V.A.Romanov.
verdogo Tela (USSR), Vol. 3, No. 1, 32-5 (Jan., 1961).
ssian.
he time constant of photoconductivity and photomagnetic e.m.f. xamined in both n- and p-type germanium. The dependence of agnitude on the value of the applied surface electric fields nvestigated using a rectangular voltage waveform. A wide ge range was covered and the results are discussed. [English lation in: Soviet Physics – Solid State (USA), Vol. 3, No. 1, July, (1961)]. K.N.R.Taylor

461 OSCILLATORY PHOTOCONDUCTIVITY IN InSb.
W.Engeler, H.Levinstein and C.Stannard.
. Rev. Letters (USA), Vol. 7, No. 2, 62-3 (July 15, 1961).
ollowing oscillatory processes discovered in Cu-doped InSb, imental evidence is presented for similar effects in crystals 1 with Ag and Au and investigated at helium temperatures. A tive explanation of the effects is offered. C.A.Hogarth

2462 PHOTOELECTRIC COLORING OF LEAD OXIDE.
M.S.Kosman and V.A.Izvozchikov.
tverdogo Tela (USSR), Vol. 3, No. 1, 119-22 (Jan., 1961).
.ssian.
The colouring of PbO during simultaneous application of ination and electric field was studied and the electrical uctivity and reflection coefficient measured. The effects of ng and moisture were examined and some theories discussed. lish translation in: Soviet Physics—Solid State (USA), Vol. 3, 1, 85-7 (July, 1961)]. D.J.Huntley

2463 COLLISION RECOMBINATION IN Tl_2S.
J.W.Ostrowski.
phys. Polon. (Poland), Vol. 19, No. 3, 339-68 (1960).
The relaxation of photoconductivity in semiconducting microstalline Tl_2S layers was investigated. The hypothesis of collin recombination of free current carriers in the process of ay of the photoconductivity was put forward and verified. A nomenological model of recombination: $r = \alpha np^2$ was proposed umber of acts of recombination per cm^3 and sec; α=coefficient ecombination; n, p=densities of free electrons and holes, pectively). A recombination coefficient $\alpha = 10^{-30}$-10^{-31} cm^6 $^{-1}$ and a relaxation time of τ = 0.5-5 msec were obtained. The ation of the recombination curve was derived. The temperature endence of the relaxation time and electric conductivity was estigated. The parameters determining the conditions of ombination density of free carriers, their mobility, the conduct, the position of the Fermi level and that of the acceptor level e evaluated.

12464 POSITIVE HOLE MOTION AND PHOTOVOLTAIC EFFECTS IN ZINC CADMIUM SULFIDE PHOSPHORS.
allmann, B.Kramer, F.Spagnolo and G.M.Spruch.
s. Rev. (USA), Vol. 123, No. 5, 1661-5 (Sept. 1, 1961).
Information was gained about the free carriers in activated and ctivated ZnCdS phosphors through a study of the photovoltaic ct in these materials. The photovoltages produced in activated dS phosphors by illumination with various wavelengths parallel absorption spectra of these materials and do not depend strongly n the type of activation. The photovoltages are brought about by ffusion of electrons from the excited region into the interior of sample. The addition of lead as a coactivator reduces the age because it increases the recombination rate. In unactivated the size of the photovoltage again parallels the absorption ctrum but its sign is reversed, indicating that positive charges are the more mobile carriers. Unactivated CdS exhibits voltages similar to the activated materials. Insulating one electrode affects the size of the photovoltage appreciably only for the unactivated materials, showing that charge exchange at the electrode is important for them and not for the activated materials.

Thermoelectric Properties

12465 THE THERMO-ELECTROMOTIVE FORCE OF SOME METALLIC BORIDES AND CARBIDES IN CONTACT WITH COPPER. H.V.Samsonov and N.S.Stryel'nikova.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 135-8 (1958). In Ukrainian, with summary (1 p.) in Russian.

The thermoelectric power was measured of TiB_2, ZrB_2, VB_2, NbB_2, CrB_2, Mo_2B_5, W_2B_5, CaB_6, BaB_6, LaB_6, CeB_6, ThB_4, ThB_6, NdB_6, PrB_6 and TiC, ZrC, VC, NbC, TaC, Cr_3C_2, Mo_2C, WC, in in the form of cylindrical specimens (diameter = 6 – 8, length = 25 – 30 mm) sintered from powders, in contact with copper. It was found that: (1) the thermoelectric power of the borides is lower than that of the carbides; (2) the power decreases on passing from carbides of metals with highly degenerate d-levels of electrons to carbides of metals with less degenerate d-levels; (3) the power of metal borides behaves in a similar way. An interpretation of this dependence found is proposed.

12466 THEORY OF THERMOELECTRIC POWER OF IONIC CRYSTALS. IV. E.Haga.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1949-54 (Nov., 1960).

For Pt III see Abstr. 1113 of 1961. The thermoelectric power Q associated with the movement of Ag ions in Ag_2X (X = S, Se, Te) is discussed, where Q is obtainable by measuring the potential difference between silver electrodes in an arrangement as

$$Ag(T_1) \mid AgI(T_1) \mid Ag_2X \mid AgI(T_2) \mid Ag(T_2).$$

When a temperature gradient is applied, Q, in general, changes with time because of the thermal diffusion of both electrons and silver ions, and then reaches its steady value. Information on the heat of transport of a silver ion is obtained from the comparison between theory and experiment. An explanation on the heat of transport in ionic crystals is given taking into account the variation of vibration frequency of the lattice due to the presence of defects. The theory is compared with the experimental data on silver halides and Ag_2X available at present.

12467 ON PROPOSED SEMICONDUCTOR THERMOBATTERIES FOR REFRIGERATORS. V.A.Naer and S.A.Rozhentseva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1125-31 (April, 1961).
In Russian.

For abstract, see Abstr. 11903 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 818-21 (Oct., 1961)].

Dielectric Properties

12468 INFLUENCE OF IRRADIATION BY THERMAL NEUTRONS ON THE DIELECTRIC PROPERTIES OF ALKALI-HALIDE CRYSTALS. V.V.Krasnopevtsev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 214-16 (Jan., 1961).
In Russian.

Single crystals of KBr and NaCl were irradiated with thermal neutrons using integral doses of 10^{16} and 10^{17} cm^{-2}. The loss tangents, dielectric constants, conductivities and absorption spectra in the visible region were measured and compared with the corresponding quantities for non-irradiated specimens. The curves of log tan δ against 1/T (T is the absolute temperature) for irradiated KBr show maxima at about 120° C and the absorption spectra of irradiated KBr and NaCl show F- and M-bands. The curves for the control specimens show none of these effects. The connection between the maxima in the loss tangent curves and the existence of F- and M-bands in the absorption spectrum is explained in terms of F-centre and vacancy formation. [English translation in: Soviet Physics — Solid State (USA), Vol. 3, No. 1, 156-7 (July, 1961)]. R.F.S.Hearmon

DIELECTRIC LOSSES AT LOW TEMPERATURE.
See Abstr. 12359

12469 MICROWAVE BEHAVIOR OF DEBYE–HÜCKEL CLOUDS IN AgBr.
G.Everett, A.W.Lawson and G.E.Smith.
Phys. Rev. (USA), Vol. 123, No. 5, 1589-94 (Sept. 1, 1961).

The real and imaginary parts of the complex dielectric constant, $\epsilon' - i\epsilon''$, were measured at 24 kMc/s as a function of temperature between 30° and 400° C. A maximum in ϵ' is observed near 350° C; ϵ'' increases rapidly, asymptotically approaching the value observed at lower frequencies in the intrinsic range near the melting point. These results are not explicable in terms of the currently accepted form of the Debye–Falkenhagen dispersion theory. A crude model is discussed which suggests that an alternative solution of the differential equation occurring in this theory affords an appropriate description of the observed behaviour.

12470 DISPERSION OF THE PERMEABILITY AND PERMITTIVITY OF ARTIFICIAL DIELECTRICS IN THE FREQUENCY RANGE 500-3500 Mc/s. I.A.Deryugin and M.A.Sigal.
Zh.. tekh. Fiz. (USSR), Vol. 31, No. 1, 100-8 (Jan., 1961).
In Russian.

For abstract, see Abstr. 10074 of 1961. [English translation in: Soviet Physics – Technical Physics (USA), Vol. 6, No. 1, 72-7 (July, 1961)].

MULTIPLE SHOCK WAVE STRUCTURES IN POLYCRYSTALLINE FERROELECTRICS. See Abstr. 11778

12471 MEASUREMENT OF MICROWAVE DIELECTRIC CONSTANTS OF FERROELECTRICS. I. DIELECTRIC CONSTANTS OF $BaTiO_3$ SINGLE CRYSTAL AT 3.3 kMc/s.
E.Nakamura and J.Furuichi.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1955-60 (Nov., 1960).

Horner et al's method of dielectric measurement in the microwave region [Abstr. 789B of 1946; J. Instn Elect. Engrs, Pt III, 53-68 (Jan., 1946)] was extended so that it could be applied for cylindrical specimens of arbitrary cross-sections with relatively high loss tangent and high permittivity. A small amount of the specimen is enough for the method. As a first application, dielectric constants of a $BaTiO_3$ single crystal were measured from room temperature to 170° C at a frequency of 3.3 kMc/s. Above the Curie point, dielectric constants measured at 3.3 kMc/s agree well with those measured at 24 kMc/s by Benedict and Durand (Abstr. 7889 of 1958), while the loss tangents slightly above the Curie point are 0.01 ± 0.007 compared to 0.1 in the case of Benedict and Durand.

12472 DIELECTRIC PERMITTIVITY VARIATIONS IN $BaTiO_3$ SINGLE CRYSTALS AND CERAMICS RESULTING FROM HYDROSTATIC PRESSURE.
J.Klimowski and J.Pietrzak.
Acta phys. Polon. (Poland), Vol. 19, No. 3, 369-81 (1960).

The effect of hydrostatic pressure on the dielectric properties of $BaTiO_3$ monocrystals and a ceramic below and above the Curie point was investigated. Curves of the permittivity versus the temperature, for various values of the pressure, were obtained. The maximum hydrostatic pressure was 2 000 kg/cm². The reciprocal value of the dielectric permittivity, $1/\epsilon$, was found to decrease linearly below the Curie point and to rise linearly above the Curie point, as the pressure increased, both in monocrystals and in the ceramic. The Curie point and Curie–Weiss temperature (the temperature of the catastrophe for the cubic phase) decrease linearly as the pressure rises, at a rate of -4.1×10^{-3} deg C/atm and -3.6×10^{-3} deg C/atm for the crystals and -4.5×10^{-3} deg C/atm for the ceramic. The Curie–Weiss constant is not modified by pressure. The maximum value of the permittivity of a monocrystal rises with the pressure and the $\epsilon(T)$ curve becomes steeper; in the ceramic, ϵ decreases and the curve flattens. The results obtained above the Curie point were compared with Devonshire's theory. Using the authors' experimental results, the coefficient of volume electrostriction η was computed. Moreover, delayed effects resulting from hydrostatic pressure pulses were investigated.

12473 FERROELECTRIC PROPERTIES OF MONOCRYSTALS OF NEW PEROVSKITE-TYPE COMPOUNDS.
V.A.Bokov and I.E.Mȳl'nikova.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2728-32 (Nov., 1960).
In Russian.

$PbNi_{1/3}Ta_{2/3}O_3$, $PbMg_{1/3}Ta_{2/3}O_3$, $PbCo_{1/3}Nb_{2/3}O_3$, $PbCo_{1/3}Ta_{2/3}O_3$ and $PbZn_{1/3}Nb_{2/3}O_3$ monocrystals were grown; they had perovskite-type structure. Studies of the temperature dependences of permittivity and tan δ and the electric-field dependence of polarization showed that these compounds were ferroelectrics. [English translation in: Soviet Physics-Solid State (USA)].

A.Tybulewicz

12474 INVESTIGATION OF THE DIELECTRIC PROPERTI OF STRONTIUM–BISMUTH TITANATES AT LOW TEMPERATURES.
A.N.Gubkin, A.M.Kashtanova and G.I.Skanavi.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1110-16 (April, 1961).
In Russian.

Results are given for permittivity, loss tangent and dielectr hysteresis in the system $SrTiO_3$–Bi_2O_3–$3TiO_2$ at various freque up to 5 kc/s and temperatures between −250° and 0° C. Relaxati polarization and ferroelectric behaviour both occur in the syste [English translation in: Soviet Physics – Solid State (USA), Vol No. 4, 807-11 (Oct., 1961)]. R.F.S.Hear

12475 THE EFFECT OF IRRADIATION WITH SLOW NEUTRONS ON DIELECTRIC PROPERTIES OF POLYCRYSTALLINE TITANATES. L.K.Vodop'yanov and G.I.Sk
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 2, 253-6 (1960).
In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of Mg, Zn, Ca, Sr, Bi, Ba and Sr–Bi titanates were irradiated in a nuclear reactor with thermal neutron fluxes of 10^{17}, 10^{18} and 10^{19} neutrons/cm². Ti(n,γ) reactions in titanate produced large numb of Frenkel-type defects. Formation of these defects led to the appearance of relaxation polarization with increase of tan δ and permittivity (when permittivity was not too great before irradiati e.g. Mg and Zn titanates). A.Tybule

12476 THE EFFECTS OF ULTRAVIOLET LIGHT ON FERROELECTRIC TRIGLYCINE SULPHATE.
I.M.Sil'vestrova and N.A.Romanyuk.
Kristallografiya (USSR), Vol. 5, No. 1, 147-50 (Jan.-Feb., 1960).
In Russian.

Double hystersis loops are shown to develop in triglycine sulphate crystals when irradiated with ultraviolet light of wavele < 250 mμ. The permittivity, elastic constant S_{33}, and piezoelect modulus d_{33} are also charged by irradiation. It is shown that the effects are not produced by surface damage, but the yellow disco ation of the surfaces does suggest some chemical deterioration i the irradiated crystals. [English translation in: Soviet Physics– Crystallpgraphy (USA), Vol. 5, No. 1, 138-41 (July-Aug., 1960)]. L.E.Cr

12477 THE EFFECT OF FLEXURAL STRESSES ON THE DIELECTRIC PROPERTIES OF POLYCRYSTALLINE BARIUM TITANATE. T.Krajewski.
Acta phys. Polon. (Poland), Vol. 19, No. 6, 731-42 (1960).

The effect of constant and acoustic-frequency variable flexu stresses on the dielectric properties of $BaTiO_3$ polycrystals was investigated. The variations of the permittivity resulting from bending a polycrystalline sample were measured in their depend on the strain, polarizing field strength and temperature. Within ferroelectric region, flexural stress was found to raise the perm tivity, independently of the direction of bending. A reversal of t sign of the permittivity variation resulting from extension was o served to occur above the Curie point. The relative variations o the permittivity as measured in the steady state some minutes a application of flexural stress are one order of magnitude smalle than those resulting from homogeneous one-dimensional pressur

ELECTRICAL CONDUCTION IN POLYCRYSTALLINE LEAD ZIRCONATE-TITANATE. See Abstr. 12423

12478 ANTIFERROELECTRIC PROPERTIES OF SOLID SOLUTIONS BASED ON $Pb\,Mg_{1/2}\,W_{1/2}\,O_3$.
G.A.Smolenskii, N.N.Krainik and A.I.Agranovskaya.
Fiz. tverdogo Tela, Vol. 3, No. 3, 981-90 (March, 1961). In Russ

The properties investigated include temperature dependence permittivity and relative extension, and phase and hysteresis diagrams. The phase transition from the antiferroelectric to the paraelectric state is accompanied by an increase in volume; on increasing the temperature of some of the solid solutions the pha are successively ferroelectric, antiferroelectric and paraelectri The effect of an electric field on the phase relationships is also studied, and the relative stability of the ferroelectric and anti-ferroelectric phases is discussed. [English translation in: Sovi Physics – Solid State (USA), Vol. 3, No. 3, 714-20 (Sept., 1961)]. R.F.S.Hear

DIELECTRIC BREAKDOWN IN CdS. See Abstr. 12426

479 PARTIAL BREAKDOWN AND EMISSION OF RADIATION BY NaCl CRYSTALS IN STRONG ELECTRIC FIELDS.
M orbin.
erdogo Tela (USSR), Vol. 2, No. 10, 2493-6 (Oct., 1960).
sian.
isible radiation emitted by rocksalt during partial breakdown d that: (1) growth of a discharge channel was accompanied by ion of light; (2) discharge in an inhomogeneous field began he positive electrode; (3) the mean rate of discharge propaga- as of the order of 10^6 cm/sec; (4) emission of light suggested ner mechanism of breakdown. [English translation in: Soviet cs—Solid State (USA), Vol. 2, No. 10, 2221-4 (April, 1960)].
A.Tybulewicz

2480 THE EFFECT OF FLEXURAL STRESSES ON THE PIEZOELECTRIC PROPERTIES OF POLYCRYSTAL- BARIUM TITANATE. T.Krajewski.
phys. Polon. (Poland), Vol.19, No. 6, 743-58 (1960).
The piezoelectric effect produced in polycrystalline barium ite by flexural stress was investigated by the static and quasi- methods. Samples in the form of two-layer rods of 1 × 3 × m dimensions were used. Flexural stress in non-polarized O_3 rods was found to induce piezoelectric charge on the sur- perpendicular to the plane of bending. The effect of strain emperature was measured. The investigation dealt also with iezoelectric effect in polarized polycrystalline $BaTiO_3$ rods ts dependence on the strain, the duration of polarization and olarizing field strength. A mechanism accounting for the tion of piezoelectric charge is proposed.

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

OPTICAL PROPERTIES OF P-TYPE CdTe CRYSTALS. Abstr. 12445

MEASUREMENT OF OPTICAL PROPERTIES OF FRESHLY APORATED FILMS. See Abstr. 11836

12481 FREE-CARRIER VOIGT EFFECT IN SEMI-CONDUCTORS. S.Teitler, E.D.Palik and R.F.Wallis.
s. Rev. (USA), Vol. 123, No. 5, 1631-3 (Sept. 1, 1961).
Measurements of the Voigt and the Faraday effects were made samples of n-type InAs and InSb. The Voigt and Faraday data used together to obtain values of both the effective mass and ncentration of free carriers which are consistent with values given other methods. An experimental technique for measurement of all phase shifts in the Voigt effect is described.

12482 PHOTOELASTIC BEHAVIOR OF RUBIDIUM HALIDES. T.S.Narasimhamurty.
Opt. Soc. Amer., Vol. 51, No. 8, 914 (Aug., 1961).
The results of stress birefringence measurements at a wave- gth of 5893 A on single crystals are given and compared with results of Iyengar and Bansiger (Abstr. 10882 of 1959) for assium halides. Mueller's prediction that (q_{11}-q_{12}) should be itive and q_{44} negative is confirmed. Both rubidium and potassium ides behave as positive uniaxial crystals when stressed along ube axis and as negative uniaxial crystals when stressed along ube diagonal. The birefringence of the rubidium halides is ch greater than that of potassium halides. H.G.Jerrard

12483 PHOTOELASTIC CONSTANTS OF AMMONIUM DIHYDROGEN PHOSPHATE (ADP).
Achyuthan and M.A.Breazeale.
Opt. Soc. Amer., Vol. 51, No. 8, 914-15 (Aug., 1961).
The stress photoelastic constants q_{13} and q_{33}, the strain optic stants p_{11}, p_{12}, p_{13}, p_{31}, p_{33} and the ratios p_{12}/p_{11} and p_{13}/p_{33} are en. They were obtained using Carpenter's data (Abstr. 9151 of 54), the elastic constants given by Bechmann [Proc. Roy. Soc. B 3) Vol. 64, 323 (1951)] and the authors' own experimental results ained by an ultrasonic technique suggested by Mueller (1938).
H.G.Jerrard

THE FARADAY EFFECT IN NON-DEGENERATE SEMI- NDUCTORS. See Abstr. 12431

12484 MICROWAVE MODULATION OF THE ELECTRO-OPTIC EFFECT IN KH_2PO_4. I.P.Kaminow.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 528-30 (May 15, 1961).
KH_2PO_4 is transparent between 4000 and 13 000 A, having a ferroelectric phase transition at 120° K. The author shows that the material exhibits a linear electro-optic effect at room tempera- ture when modulated at 9.25 kMc/s. It is suggested that the effect might be observed at higher modulating frequencies and might be enhanced at shorter wavelengths that the 8000 A radiation used in these experiments. I.Cooke

DIFFUSE REFLECTION SPECTRA OF $(ZnSe)_x$-$(CdSe)_y$. See Abstr. 12363

12485 THE RESONANCE TYPE ABSORPTION OF VERY THIN SILVER AND GOLD FILMS. S.Yamaguchi.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1577-85 (Sept., 1960).
The spectral transmission from 200 mμ to 1200 mμ of silver and gold thin films was measured. It was found that for heated silver films a strong resonance type absorption appeared with the peak at 435 mμ - 480 mμ and then the absorption due to electrons in the conduction band disappeared. For heated gold films, similar results were also obtained but the absorption strength was rather weak and the peak position shifted to 510 mμ - 550 mμ. By taking into account the two dimensional aggregations, some dis- cussions were made from the view point of the collective motion of conduction electrons within small metallic particles of which the film was composed.

12486 TEMPERATURE DEPENDENCE OF THE OPTICAL ABSORPTION EDGE OF TUNGSTEN TRIOXIDE SINGLE CRYSTAL. T.Iwai.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1596-600 (Sept., 1960).
The optical absorption edge of a WO_3 single crystal was measured with polarized light over the temperature range from −100° to 900° C. From 0° to about 700° C, the absorption edge shifts linearly toward the red with increasing temperature, the tempera- ture coefficients being -9.0×10^{-4} eV deg^{-1} for the case of light polarized in the direction parallel to the a-axis (a-polarized light) and -6.5×10^{-4} eV deg^{-1} for the case of light polarized in the direction parallel to the c-axis (c-polarized light), respectively. In the vicinity of −50° C, an anomalous shift of the absorption edge takes place. This is attributed to the phase transition. In the low temperature phase, the extinction position is different from that in the high temperature phase. In addition, when the temperature is raised through 740° C, a sudden red shift takes place for the case of a-polarized light, the magnitude being about 0.35 eV, while no anomaly occurs for c-polarized light.

12487 OPTICAL PROPERTIES OF n-TYPE INDIUM ARSENIDE IN THE FUNDAMENTAL ABSORPTION EDGE REGION. J.R.Dixon and J.M.Ellis.
Phys. Rev. (USA), Vol. 123, No. 5, 1560-6 (Sept. 1, 1961).
The optical properties were studied experimentally as a function of impurity content over a temperature range from 18° to 300° K. The addition of donor impurities moves the absorption edge to higher energies and changes its shape in accordance with the theory of Burstein. For nondegenerate material the energy depend- ence of absorption coefficients larger than 10^3 cm^{-1} is $\alpha^2 = 3.0 \times \times 10^5 (E - 0.35)$ cm^{-2} at room temperature and is in good agree- ment with calculations by Stern based on a nonparabolic conduction band. Absorption coefficients below 10^3 cm^{-1} depend exponentially upon energy down to at least 3 cm^{-1}, a result which has not yet been explained. The addition of acceptor impurities to the purest material available moves the absorption edge to lower energies by an amount which increases with the acceptor concentration. When 2.4×10^{17} cm^{-3} acceptor atoms are added, the absorption edge measured at 100 cm^{-1} is shifted by 0.013 eV. The temperature dependence of the forbidden energy gap was found to be linear from 300° to 80° K with a temperature coefficient of -2.8×10^{-4} eV/° K. Below 80° K the change of the energy gap with temperature becomes smaller and nonlinear. It is estimated that lattice dilation accounts for only one-fourth of the total variation of the energy gap with temperature. The radiative lifetime of added carriers in intrinsic material at room temperature was calculated from the optical constants by the method of van Roosbroeck and Shockley and was found to be 1.3×10^{-5} sec.

12488 THERMAL TUNING OF RUBY OPTICAL MASER. I.D.Abella and H.Z.Cummins.
J. appl. Phys. (USA), Vol. 32, No. 6, 1177-8 (June, 1961).

An experimental investigation of the R_1 line output of a ruby maser (6943 A at 20°C) is reported. The output is 100% plane polarized, and the frequency is temperature-dependent with a shift of 0.065 A/deg C from about −80° to +80°C. Since maser action is best at line peak, and since the spectral width is of the order of the temperature shift, good temperature control is necessary for frequency stability in ruby maser operation. P.M.Parker

12489 COHERENT STIMULATED EMISSION FROM ORGANIC MOLECULAR CRYSTALS.
E.G.Brock, P.Csavinszky, E.Hormats, H.C.Nedderman, D.Stirpe and F.Unterleitner.
J. chem. Phys. (USA), Vol. 35, No. 2, 759-60 (Aug., 1961).

The properties of conjugated molecules strongly suggest several methods in which maser action may be obtained. At microwave frequencies, the population of the Zeeman levels of the first triplet state may be used, and this maser action would occur only when optical excitation was applied. Stimulated emission at optical wavelengths is proposed using radiative transitions from metastable triplet states. Factors affecting the feasibility of these experiments are discussed. J.Sheridan

12490 EFFECT OF PRESSURE ON THE SPECTRA OF CERTAIN COMPLEXES OF Cu^{++}, Co^{+++}, AND Fe^{++}.
D.R.Stephens and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 2, 424-6 (Aug., 1961).

The effect of pressure was measured on the spectra of four Cu^{++} salts, and on K_3COF_6 and $FeSiF_6.6H_2O$. The four Cu^{++} salts have varying degrees of distortion from octahedral (or tetrahedral) symmetry. For the Tutton's salt (the more distorted octahedral complexes) there were measurably larger effects on the shift and especially on the intensity of the transition. The Co^{3+} and Fe^{++} systems were compared to investigate the possibility of crossover from spin free to spin paired arrangement in the former. From the data it is estimated that this should occur at 220-250 kbar.

12491 EFFECT OF PRESSURE ON THE SPECTRUM OF RUBY. D.R.Stephens and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 2, 427-9 (Aug., 1961).

The effect of pressure was measured on the spectrum of ruby, both parallel and perpendicular to the C axis, to 120 kbar. From these data it is possible to calculate the change in crystal field strength Dq in interelectronic repulsion B and in trigonal field distortion ($-\frac{3}{2}K$). The crystal field increases with increasing pressure, while the interelectronic repulsion decreases, indicating increasing covalency. The trigonal distortion is constant to about 60 kbar, and then increases markedly at higher pressures. The fractional change in Dq with pressure follows the R^{-5} law closely to 30 kbar, the upper limit of the p-v data.

12492 EFFECT OF PRESSURE ON TETRAHEDRAL Ni^{++} AND Co^{++} COMPLEXES. D.R.Stephens and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 2, 429-35 (Aug., 1961).

The effect of pressure was studied on the spectra of five tetrahedral Co^{++} complexes and two tetrahedral Ni^{++} complexes. Calculations are made for the change in the crystal-field parameter 10 Dq and for the change in the interelectronic repulsion B. The increase in 10 Dq and the decrease in B correlates strongly with the polarizibility of the ligands. For the Co^{++} complexes the effect of pressure on the spin-orbital splitting was studied. The splitting increased with pressure to an extent determined by the mass and polarizability of the ligand. For ZnS compressibility data were available. It was found that the fractional change in Dq for both Co^{++} and Ni^{++} was greater than that predicted from the bulk compressibility of ZnS. This is attributed to relaxation in the neighbourhood of the foreign ion.

12493 ABSORPTION AND FLUORESCENCE SPECTRA WITH MAGNETIC PROPERTIES OF $ErCl_3$.
G.H.Dieke and S.Singh.
J. chem. Phys. (USA), Vol. 35, No. 2, 555-63 (Aug., 1961).

The absorption and fluorescence spectra of $ErCl_3$ diluted by $LaCl_3$ are given with the Zeeman effects of many of the lines. All expected electronic levels to 30 000 cm^{-1} above the ground state are found, and their interpretation fits into the theoretically expected scheme. Examples are also given of the absorption and fluorescence spectrum of pure $ErCl_3$ which show that the pure salt must have a structure quite different from that of $LaCl_3$.

12494 OPTICAL PROPERTIES OF KCl:Tl IN THE EXTREM ULTRAVIOLET REGION. K.Aoyagi and G.Kuwabara.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2334-42 (Dec., 1960).

The optical properties of KCl:Tl in the vacuum ultraviolet range were studied between room and liquid nitrogen temperature A new band was observed in both the absorption and excitation spectra on the long wave length tail of the exciton band, i.e. 7.19 at −180° C. From the measurements of the temperature dependen and the emission spectrum the band is supposed to be associated with a transition in Cl ions in the neighbourhood of a Tl ion. Excitation and emission spectra of fluorescence by the light in th fundamental band region, as well as thermal glow and optical stimulation curves of phosphorescence were also measured. The process of this luminescence is discussed.

12485 OSCILLATIONS OF THE ABSORPTION COEFFICIEN OF [MONOCRYSTALLINE] TELLURIUM IN A MAGNETIC FIELD DIRECTED ALONG THE CRYSTAL OPTICAL AXIS. L.I.Korovin and T.Yu.Bulashevich.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2795-2804 (Nov., 1960) In Russian.

Derives the infrared absorption spectrum in a magnetic field directed along the symmetry axis of the crystal. Discusses the frequency region near 0.1 eV where absorption is due to direct transitions of electrons into a hole band from a completely filled valence band lying below the hole band. The calculation is carried out in the one-electron approximation using the effective-mass method. [English translation in: Soviet Physics—Solid State (USA), Vol. 2, No. 11, 2589-97 (May, 1961)]. A.Tybulewi

12496 STUDIES OF THE EFFECT OF ORIENTATED DEFOR MATIONS ON THE SPECTRUM OF THE FUNDAMEN ABSORPTION EDGE OF Cu_2O MONOCRYSTALS.
E.F.Gross and A.A.Kaplyanskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2968-81 (Nov., 1960). In Russian.

Unidirectional compression produced anisotropic polarized splitting of the fundamental edge and the exciton structure in the absorption spectrum. The multiplicity and magnitude of splitting and polarization were studied as a function of the direction of compression. The observed effects were explained by removal o triple degeneracy of the valence band at K = 0 by the applied compression. [English translation in: Soviet Physics—Solid St (USA), Vol. 2, No. 11, 2637-50 (May, 1961)]. A.Tybulew

12497 STRETCHING VIBRATION OF SULPHATE ION IN POTASSIUM CHLORIDE: FORMATION OF $M^{++}SO_4^{--}$ PAIRS. E.H.Coker, J.C.Decius and A.B.Scott.
J. chem. Phys. (USA), Vol. 35, No. 2, 745-6 (Aug., 1961).

Single crystals of KCl doped with K_2SO_4 show a series of ban in the region of the stretching fundamental (1000-1200 cm^{-1}). Doping with $MgSO_4$, $CaSO_4$, $BaSO_4$ or $PbSO_4$ (the sulphate presuma being present substitutionally on Cl^- sites) causes most of the ban to disappear or shift. The splitting of the triply degenerate sulph stretching mode was estimated for the above cations using a simple perturbation calculation; the findings agree very well with experimental results. D.L.Greenaw

12498 ABSORPTION SPECTRA OF VANADIUM, NIOBIUM AND TANTALUM PENTOXIDES.
D.C.Conlon and W.P.Doyle.
J. chem. Phys. (USA), Vol. 35, No. 2, 752-3 (Aug., 1961).

Thin films of these three oxides (prepared by evaporation of metal and subsequent oxidation) show a fundamental absorption r starting at photon energies of between 3 and 4 eV. The region of high absorption ($k = 10^5$ to 10^6 cm^{-1}) is attributed to either excito or band-to-band transitions. In this region tantalum pentoxide al exhibits photoconductivity which supports this conclusion. D.L.Greena

12499 RAMAN SPECTRA OF CRYSTALLINE DOUBLE SULPHATES. V.Ananthanarayanan.
Z. Phys. (Germany), Vol. 163, No. 2, 144-57 (1961).

Raman spectra of single crystals of $K_2M(SO_4)_2.6H_2O$ where M = Mg, Zn, Ni or Co were recorded for the first time using λ2537 as the exciting radiation. The corresponding five single sulphates were also studied. Interesting results concerning the substitution of magnesium, zinc, nickel or cobalt in the double sulphate lattice on the sulphate frequencies are observed. The lattice spectra of these double sulphates are analysed group theo tically and discussed in relation to the lattice spectra of the

esponding individual sulphates. Certain new results concern- he Raman spectra of the individual sulphates were also ned and in the case of $CoSO_4 \cdot 7H_2O$ the spectrum was recorded he first time.

12500 RAMAN SPECTRUM OF STRONTIUM TITANATE. P.S.Narayanan and K.Vedam.
hys. (Germany), Vol. 163, No. 2, 158-64 (1961).
The Raman spectrum of strontium titanate was recorded using 58 of mercury as exciter. The observed spectrum consists of aman lines, one of which is of low frequency, as expected from theory of Cochran (Abstr. 1565 of 1960; 8971 of 1961). Six of e Raman lines are interpreted as the first-order spectrum sing from a small deviation of the cubic strontium titanate from idealized symmetry. It is shown that one normal mode of $SrTiO_3$ lected by Last (Abstr. 4153 of 1957), will be really active in ared absorption in the region of 440 cm^{-1} and that it has to be en into account in the interpretation of the infrared spectra of nates. The four vibrational modes of the unit cell of $SrTiO_3$ respond to frequencies of 90, 335, 441 and 620 cm^{-1} observed in Raman effect. The large width of the Raman lines and the ditional lines at 256 cm^{-1} and 726 cm^{-1} are attributed to a split- g of the longitudinal and transverse optical modes. With the served frequencies it is found possible to account in a satisfactory nner for the specific heat of $SrTiO_3$ in the range 54.84° to 1800° K.

12501 FINE STRUCTURE OF THE K X-RAY ABSORPTION EDGE OF GERMANIUM. J.N.Singh.
ys. Rev. (USA), Vol. 123, No. 5, 1724-9 (Sept. 1, 1961).
A double-crystal spectrometer, with a proportional counting stem for intensity measurement, was employed for the investiga- n of the X-ray absorption structure on the high-energy side of Ge K edge, using 38% polarized X-rays and a thin single crystal germanium in the transmission method. The structure was died up to 185 eV from the main edge and several new absorption ructure features, not reported hitherto, were obtained. These atures are satisfactorily explained by Hayasi's theory (1949) in the ose-in region and by Kronig's theory (1931) in the extended region. significant shift, without any intensity variation, was noted in the tended fine structure on changing the orientation of the single- ystal absorber. A quantitative correlation is made between the served structures and the theoretically predicted values with a ew to testing different theories on absorption fine structure.

DIFFRACTOMETER MEASUREMENT OF THE CHARACTER- IC ABSORPTION OF X-RAYS. See Abstr. 11995

uminescence

12502 VALENCE OF THE MANGANESE ACTIVATOR IN CRYSTAL PHOSPHORS. V.V.Osiko and G.V.Maksimova.
otika i Spektrosk. (USSR), Vol. 9, No. 4, 478-81 (Oct., 1960). Russian.
The valence state of the manganese activator was determined emically in 48 crystal phosphors. The results showed that: (1) all phosphors with green and yellow luminescence the average lence was 2; (2) phosphors with orange-red and red emission d manganese with the average valence of ≥2; (3) there was no ique relationship between the average valence and the ionic radii the structure of the crystals. [English translation in: Optics d Spectrosc. (USA), Vol. 9, No. 4, 248-9 (Oct., 1960)].
A.Tybulewicz

12503 THE SPECTRA AND KINETICS OF LUMINESCENCE OF CaF_2:Tb. P.P.Feofilov.
otika i Spektrosk. (USSR), Vol. 10, No. 1, 142-4 (Jan., 1961). Russian.
Two similar sequences of line groups, displaced with respect one another by 5800 cm^{-1}, were found in CaF_2:Tb. They lay at 0-480 mμ and 490-660 mμ. It is shown that the two sequences e due to transitions from two excited states of Tb^{3+} to the ground ate. [English translation in: Optics and Spectrosc. (USA), Vol. 10, o. 1, 70-1 (Jan., 1961)].
A.Tybulewicz

12504 ENERGY SPECTRUM OF Mn^{++} ION IN CALCIUM FLUOROPHOSPHATE. I. K.Narita.
Phys. Soc. Japan, Vol. 16, No. 1, 99-105 (Jan., 1961).
In order to find the effect of the change in the lattice constants the host crystal upon the energy levels of the activator ion, calculations were performed for the particular case of calcium fluorophosphate activated by Mn^{2+}. The wave-functions of the d^5 configuration in excited states were formed by the method of Condon and Shortley (The Theory of Atomic Spectra. Cambridge: University Press) and the matrix elements of the crystalline field potential at the Mn^{2+} ion were calculated. The Hamiltonian matrix thus obtained was diagonalized by a computer to derive the eigenvalues. On the assumption that the emission of this fluorescent body is due to the transition of Mn^{2+} ions from the lowest excited state to the ground state, the calculation leads to a shift of the emission peak by about 200 A to the longer wave length side caused by a 1% decrease in the lattice constant.

12505 SPLITTING OF THE EMISSION LINES OF RUBY BY AN EXTERNAL ELECTRIC FIELD.
W.Kaiser, S.Sugano and D.L.Wood.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 605-7 (June 1, 1961).
Reports the effects of an external electric field (E_0 = 0 to $E_0 = 1.6 \times 10^5$ V/cm) on the fluorescence transitions R_1 and R_2, characteristic of ruby containing < 0.05% of chromium. For both transitions, each component of the doublet observed at $E_0 = 0$ is split into two. The splitting is linear with E_0 and is identical for R_1 and R_2. The polarization of the emission is unaltered by E_0. No splitting is observed when E_0 is perpendicular to the optic axis of the ruby. The frequency shift is larger than that expected from the normal Stark effect, reaching 1 cm^{-1} at 1.7×10^5 V/cm. The position of the centre of the split components is unaffected by E_0. As both the initial and final states of the fluorescence are Kramers doublets, the degeneracy state should be unaffected by E_0 and no normal Stark effect should be observed. The Cr^{3+} ion occupies two distinct types of lattice site in Al_2O_3. These sites can only be interchanged by symmetry operations which include inversion at the Cr^{3+} ion. The two sites are energetically equivalent only for $E_0 = 0$. When $E_0 \neq 0$, the contribution of E_0 to the local electric field produces an odd parity interaction potential for the Cr^{3+} electron states and results in oppositely directed Stark shifts at the two sites. The other properties observed in these experiments can be readily explained on the basis of this model.
P.J.Dean

12506 THE WAVELENGTH DEPENDENCE OF QUANTUM EFFICIENCY AND ABSORPTION COEFFICIENT OF $ZnSiO_3$/Mn POWDER PHOSPHOR. I.Masuda.
J. Phys. Soc. Japan, Vol. 16, No. 1, 105-7 (Jan., 1961).
The relation between the wavelength dependence of the absorption coefficient of $ZnSiO_3$:Mn powder phosphor and that of the quantum efficiency of fluorescence as well as the relation between the latter and the activator concentration were studied. It was found out that the peak of the quantum efficiency was always at the longer wavelength side than that of the absorption coefficient, and that with decrease of Mn concentration, the quantum efficiency becomes larger, and its curve sharper. A simple theory is presented to explain these facts.

12507 ELECTROLUMINESCENCE OF INSULATED PARTICLES. II. K.Maeda.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2051-3 (Nov., 1960).
Lehmann's experimental results on the emission intensity of a single electroluminescent phosphor particle embedded in an insulating dielectric as a function of the applied voltage (Abstr. 2967 of 1960) are analysed on the model proposed in Part I (Abstr. 10861 of 1959). In this model the local field enhancement is attributed to the disturbance of the applied field due to the conducting phase of the phosphor particle. The results are reasonable and the validity of the model is confirmed.

12508 THIN-FILM ELUCIDATION OF THE ELECTRO-LUMINESCENCE PROCESS. W.A.Thornton.
Phys. Rev. (USA), Vol. 123, No. 5, 1583-6 (Sept. 1, 1961).
Very thin sulphide films emit light only on alternate half-cycles of the voltage sine wave, whereas the emission of thicker films and phosphor powders is quite symmetrical with polarity. This asymmetry of emission, together with clipping or d.c. bias of the applied voltage, is used to confirm unambiguously that the excitation and recombination steps in electroluminescence are separable and occur sequentially and under different field configurations, and that the recombination is field-driven.

MAGNETIC PROPERTIES OF SOLIDS

12509 SPIN-WAVE CONTRIBUTION TO SPECIFIC HEAT AND MAGNETIZATION IN CANTED SPIN ARRAYS.
H.Unruh, Jr and F.J.Milford.
Phys. Rev. (USA), Vol. 123, No. 5, 1619-26 (Sept. 1, 1961).

The dispersion law for spin waves in a cubic canted spin array is derived. From this dispersion law the spin-wave contributions to the specific heat and magnetization are obtained. The integrals involved in the expressions for these quantities are evaluated numerically for a moderate range of the system description parameters B and F. In a special case the behaviour of the spin-wave contribution is shown to change from $T^{3/2}$ at very low temperature to T^3 at somewhat higher temperatures. This phenomenon is discussed in terms of some available data on low-temperature spin-system specific heats.

12510 THE CURIE TEMPERATURE OF AN IMPERFECT ISING LATTICE. J.Seiden.
J. Phys. Radium (France), Vol. 21, No. 2, 141-2 (Feb., 1960).
In French.

Considerations of a previous paper (Abstr. 13761 of 1960) are extended to give a more accurate estimate of the Curie temperature for the imperfect lattice. It is now claimed that the error in $\Delta T_C = T_C - T_{CP}$ is less than 5% and that this more accurate value differs very little from the previous estimate. J.W.Leech

12511 MAGNETIC SUSCEPTIBILITY OF $CoBr_2.6H_2O$. M.Garbar.
J. Phys. Soc. Japan, Vol. 15, No. 4, 734-5 (April, 1960).

Measurements were made, by the Faraday method, of the static susceptibility of $CoBr_2.6H_2O$ in the liquid helium temperature region. Results are shown graphically for the external magnetic field oriented along each of the three principal axes. The knee in the χ_C curve indicates a Néel temperature of 3.2°K — rather higher than that obtained by Forstat, Taylor and Spence from n.m.r. and specific heat measurements (Abstr. 3099 of 1960). Measurements were also made at 80°K, giving $\chi_a = 0.026 \times 10^{-3}$/gm; $\chi_b = 0.12_3 \times \times 10^{-3}$/gm and $\chi_C = 0.11_4 \times 10^{-3}$/gm. S.A.Ahern

12512 THE MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF CHROMIUM SELENIDE. I.Tsubokawa.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2243-7 (Dec., 1960).

The magnetic susceptibilities of single crystals as well as powder specimens of chromium selenides with the compositions $CrSe_{1.00}$, $CrSe_{1.04}$ and $CrSe_{1.07}$ were measured from the boiling point of liquid He up to 900°K. The susceptibility versus temperature curves showed a break at 279°, 271° and 232°K for $CrSe_{1.00}$, $CrSe_{1.04}$ and $CrSe_{1.07}$ respectively. The anisotropy of the susceptibility increases rapidly from these breaking points to lower temperatures. There exists also a peak of the specific heat just above the room temperature which, however, lies a little higher than the breaking point mentioned above. This peak temperature of specific heat is considered to be the antiferromagnetic Néel point. Asymptotic Curie temperature θ_p, Curie constant C_M and spin quantum number S were determined from the susceptibility data in the paramagnetic region.

12513 THE CHANGE OF THE CURIE TEMPERATURE OF IRON–NICKEL ALLOYS DUE TO HYDROSTATIC PRESSURE. T.Kaneko.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2247-51 (Dec., 1960).

The change of the Curie temperature due to hydrostatic pressure was measured for two iron–nickel alloys with a nickel concentration of 30 and 32% respectively. Hydrostatic pressure was produced with an apparatus of the Bridgman type [The Physics of High Pressure. London: G.Bell (1949)] and the measurements of magnetization were performed by the ballistic method. The change of the Curie temperature due to pressure was estimated to be -3×10^{-8} and -2×7.10^{-3} deg. kg^{-2} cm^2 for specimens with a Ni concentration of 30 and 32% respectively. Based on Smoluchowski's formula (1941), the volume dependence of saturation magnetization at absolute zero $1/I_0 \cdot \partial I_0/\partial\omega$ and that of the molecular field coefficient $1/N \cdot \partial N/\partial\omega$ for a 30% Ni alloy were found to be 27 and −16 from the experimental results. Taking into consideration the volume dependence of the saturation magnetization at absolute zero, the relations between the volume dependence of the Curie temperature, molecular field coefficient and exchange integral are discussed.

12514 DIAMAGNETIC SUSCEPTIBILITY OF PYROLYTIC GRAPHITE. D.B.Fischbach.
Phys. Rev. (USA), Vol. 123, No. 5, 1613-14 (Sept. 1, 1961).

The diamagnetic susceptibilities of some pyrolytic graphites deposited at 2100-2300° C were measured at room temperature. As-deposited samples had significantly larger susceptibilities t that of well-graphitized carbons or single-crystal graphite. He treatment at temperatures above 2300° C caused the total suscep bility to decrease to a minimum value, then rise and level out a value characteristic of graphite, as a function of treatment temp ature. The relationship of the susceptibility behaviour to the structure of the pyrolytic graphite is discussed.

12515 DE HAAS–VAN ALPHEN EFFECT IN POTASSIUM. A.C.Thorsen and T.G.Berlincourt.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 617-18 (June 1, 1961).

Measurements of the de Haas–van-Alphen oscillations are reported for a single crystal of potassium in pulsed fields of up 160 kOe. The period of oscillations was found to be 5.75×10^{-9} per gauss, indicating a cross-sectional area of the Fermi surfac of 1.66×10^{16} cm^{-2}. The corresponding values calculated from free electron model are 5.69×10^{-9} per gauss and 1.68×10^{16} cm A plot of ln(a/T) against T was found to give a linear relationshi where 'a' denotes the amplitude of the oscillations and T the absc temperature. From the slope of the graph a value of (0.90 ± 10% was deduced for the effective electronic mass. The value obtain from specific heat data is 1.3 m_e. R.Pa

12516 OBSERVATIONS OF DE HAAS–VAN ALPHEN OSCILLATIONS IN P-TYPE PbTe.
P.J.Stiles, E.Burstein and D.N.Langenberg.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 667-9 (June 15, 1961).

First observation of the effect in a semiconductor. The oscillations were observed for various orientations of the magnetic field with respect to the crystal axes in samples with ~ 10^{18} holes/cm^3. The data indicate a valence band maximum at k = 0 and maxima at the centres of the {1,1,1} faces of the Brillo zone. The energy difference between the two types of maxima is very small. The energy surfaces near k = 0 vary with orientatio by about 25%. Assuming parabolic bands, the energy surfaces at the {1,1,1} faces are ellipsoids of revolution with a longitudinal-to-transverse mass-ratio of 6.4 ± 0.3. The transverse effective mass is (0.042 ± 0.006)m_e. The effective mass of the holes at k = 0 is estimated as (0.12 ± 0.02)m_e. L.Pinch

12517 THE SUPEREXCHANGE INTERACTION BETWEEN Cr^{+3} PAIR IN CHROMIUM BI-NUCLEAR COMPLEX IONS. H.Kobayashi, T.Haseda and E.Kanda.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1646-51 (Sept., 1960).

The investigation of the magnetic properties of chromium bi nuclear complex compounds was made. The results of the magne susceptibility measurements were analysed on the assumption th their magnetic behaviours are determined mainly by the super-exchange interaction between two Cr^{+3} ions in the same complex unit. The coefficient of the superexchange interaction J was estimated to be about −30 k in the cases of $[(NH_3)_5Cr\text{-}OH\text{-}Cr(NH_3$ and $[(NH_3)_5Cr\text{-}OH\text{-}Cr(NH_3)_4OH]^{+4}$ complex ions. In the case of $[(NH_3)_5Cr\text{-}O\text{-}Cr(NH_3)_5]^{+4}$, the susceptibility is very small below room temperature, hence a large absolute value of J is required account for the experimental result. The susceptibility of $[Cr(NH_3)_5Cl]Cl_2$ which is a usual mononuclear complex salt, was measured for the sake of comparison with the above mentioned b nuclear complex salts. The susceptibility obeys in this case the Curie–Weiss law in the range between 2.5°K and room temperat The Weiss constant Θ is −0.8°K ± 0.1°K and the Curie constant 1.82. The X-ray powder patterns of these complexes were taken and examined in comparison with the magnetic properties.

12518 ON THE PARAMAGNETIC SUSCEPTIBILITY OF Sm^{3+} ION. N.Uryu.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2041-50 (Nov., 1960).

The susceptibility measured by Borovik-Romanov and Krein (Abstr. 8859 of 1956) is explained on the basis of crystalline fie theory. Postulating an appropriate cubic or trigonal potential fo two modifications of Sm_2O_3, the magnetic behaviours are explain with the best choice of the coefficients of each potential. Total separations of the ground manifold 216k and 432k are obtained fo the two cases and are compared with the above authors' rough estimations 52 cm^{-1} and 150 cm^{-1}. Further, their erroneous ass ment for the lowest state is pointed out.

-19 PARAMAGNETIC SUSCEPTIBILITY OF AN ELECTRON GAS IN ALKALI METALS. M.Shimizu.
ys. Soc. Japan, Vol.15, No. 12, 2220-35 (Dec., 1960).
he paramagnetic susceptibility of an electron gas is calculated
king use of the Bohm—Pines description of electron interactions
State Physics, Vol. 1, p. 367 (Abstr. 6038 of 1956)]. The
bution from the long-range correlation to the susceptibility
ated by Pines is modified by using the larger cutoff wave
of plasma oscillations and including the new contribution
the zero-point energy of plasma oscillations. The contribution
the second-order perturbation-theoretic calculation of the
ned Coulomb interactions is obtained by a proper approximation.
ontribution from the third-order perturbation-theoretic
lation of the interactions is obtained by a rather crude approxi-
n. Comparisons of paramagnetic susceptibility with experi-
al values for alkali metals are made and the agreements for Li
a are satisfactory. The volume dependences of paramagnetic
ptibility for alkali metals are examined by comparing the
rimental results on the pressure dependence of the Knight shift
State Physics, Vol. 2, p. 128 (Abstr. 3471 of 1957)] with the
ks calculations of the Fermi interaction.

2520 MAGNETIC SUSCEPTIBILITIES OF NON-FERROMAGNETIC TRANSITION METALS.
imizu and T.Takahashi.
ys. Soc. Japan, Vol. 15, No. 12, 2236-42 (Dec., 1960).
The increases of the magnetic susceptibilities with temper-
e for non-ferromagnetic transition metals are investigated
aking use of the band picture. If the Fermi surface at the
lute zero of temperature is in the neighbourhood of a minimum
e electron state density, the susceptibility increases with
erature at lower temperatures. Instead of the band with a
mum of the electron state density use is made of the band where
standard bands are superimposed. The spin paramagnetic
eptibilities of this band are calculated numerically at arbitrary
peratures in the several cases of the position of the Fermi
face and the shape of the band, and it is shown that the sus-
ibilities increase with temperature at higher temperatures. By
paring the theoretical results with the experimental results for
susceptibilities of pure chromium and dilute alloys of iron in
omium at higher temperatures, the position and the shape of the
mi surface in the neighbourhood of the minimum of the state
sity for chromium are discussed.

12521 ON THE MAGNETIC PROPERTIES OF A $CrBr_3$ SINGLE CRYSTAL. I.Tsubokawa.
Phys. Soc. Japan, Vol. 15, No. 9, 1664-8 (Sept., 1960).
The properties were measured with a magnetic balance and also
h a torque magnetometer. The ferromagnetic Curie point was
nd to be 37°K from the temperature dependences of magnetization
l of torque. Based on the data of the magnetic susceptibility above
Curie point, the paramagnetic Curie point θ_p, Curie constant
and the effective Bohr magneton number were determined to be
K, 1.84 and 3.85 μ_B respectively. From the saturation
gnetization at 4.2°K, the moment of the chromium ion is esti-
ted to be $3\mu_B$, coinciding with the spin moment obtained from
susceptibility measurement above the Curie temperature.
rection of easy magnetization lies along the c-axis of the hexagonal
tice, and the second order and the fourth order anisotropy constants
e estimated to be $K_1 = -5.08 \times 10^6$ and $K_2 = 0.65 \times 10^6$ erg/cm^{-3}
spectively. In the present results, there is found to be a small
riation in the torque curves from simple sinusoidal form,
$= K \sin 2\theta$, which is discussed on the basis of the higher order
m of magnetic anisotropy in the high field strength range and
o of the domain-theoretical consideration in the low field strength
ge.

PARAMAGNETISM AT LOW TEMPERATURES.
Abstr. 12359

12522 THE SPIN ABSORPTION IN VARIOUS PARAMAGNETIC SALTS IN PARALLEL FIELDS. Yu.I.Nyashin.
. tverdogo Tela (USSR), Vol. 3, No. 1, 154-5 (Jan., 1961).
Russian.
Measured values of the imaginary part of the complex magnetic
ceptibilities of chrome alum, iron ammonium alum, and manga-
e ammonium alum do not vary with the field according to
rter's relation $\chi''/\chi''(0) = 1 - F$ or the relation assumed by
tain Russian investigators: $\chi''/\chi''(0) = (1-F)^3$. Here $\chi''(0)$ is
value of χ when $H_C = 0$, H_C is the variable d.c. field,
$(b/C)/(b/C + H_C^2)$, C is the Curie constant, and b is the magnetic
cific heat. However, a phenomenological theory by Shaposhnikov
(Abstr. 3829 of 1948) gives $\chi''/\chi''(0) = (1-F)^2(1 + \tau_s^2\nu^2)/\{1 + (1-F)^3\tau_s^2\nu^2\}$, where τ_s is the isothermal relaxation time of the magnetic moment, and ν is the frequency. On plotting graphs of $\chi''/\chi''(0)$ against H_C using (1) the last-mentioned equation, and (2) experimental results measured at 20.4°K, and with $\nu = 1.325 \times 10^6$ c/s, good agreement is obtained. The values of $\chi/\chi(0)$ fall away monotonically as H_C increases. [English translation in: Soviet Physics-Solid State (USA), Vol. 3, No. 1, 110-11 (July, 1961)]. N.Davy

12523 INELASTIC SCATTERING OF THERMAL NEUTRONS BY PARAMAGNETIC IONS. S.Tosima.
J. Phys. Soc. Japan, Vol. 16, No. 2, 241-50 (Feb., 1961).
For the magnetic scattering of thermal neutrons by paramagnetic ions with discrete energy levels, Trammell's theory (Abstr. 3895 of 1954) is extended to include inelastic scattering. The scattering cross-section of Eu^{3+}, Sm^{3+}, Co^{2+} in oxide and fluoride and Fe^{2+} in oxide are estimated. In these ions, the cross-sections appreciably include the inelastic parts, and depend on the temperature and the energy of the incident neutrons, i.e. the cross-sections suddenly increase when the energy of the neutron exceeds the level separations.

12524 FERROMAGNETISM OF Mn—Zn ALLOY. S.Tezuka, S.Sakai and Y.Nakagawa.
J. Phys. Soc. Japan, Vol. 15, No. 5, 931 (May, 1960).
The ferromagnetism previously found for 25-30% Mn—Zn is shown to be due to the existence of a metastable close packed hexagonal phase which is produced by annealing a quenched alloy at about 80°C. Further annealing at higher temperatures produces a face-centred cubic phase with a Curie temperature of 140°K compared with 400°K for the hexagonal phase. D.J.Oliver

12525 MAGNETIC PROPERTIES OF $KMnF_3$. II. WEAK FERROMAGNETISM.
A.J.Heeger, O.Beckman and A.M.Portis.
Phys. Rev. (USA), Vol. 123, No. 5, 1652-60 (Sept. 1, 1961).
For Pt I, see Abstr. 2464 of 1961. The static magnetic properties of single-crystal $KMnF_3$ were studied by magnetic torsion measurements. These measurements are consistent with a transition to uniaxial antiferromagnetism below 88.3°K. Below 81.5°K the magnetic behaviour is complex with the development of hysteresis and discontinuities in the torsion. Further, the torsion increases linearly with magnetic field in this range. These observations suggest the development of weak ferromagnetism in this crystal below 81.5°K. From a comparison of the direction of the weak moment and the known distortions in the crystal structure it is concluded that the weak moment results from a canting of the magnetic sublattices because of differences in the sublattice anisotropy. Between 81.5° and 88.3°K a moment appears only in strong magnetic fields. It is shown that the moment is developed in a field because of the increased parallel susceptibility of a canted antiferromagnet. The canting transition is interpreted as a first-order transition of the Jahn—Teller type. The antiferromagnetic transition itself is associated with a change in lattice parameter and is interpreted as an exchange-controlled first-order transition.

12526 FERROMAGNETISM IN SOLID SOLUTIONS OF SCANDIUM AND INDIUM.
B.T.Matthias, A.M.Clogston, H.J.Williams, E.Corenzwit and R.C.Sherwood.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 7-9 (July 1, 1961).
Alloys in the composition range from $Sc_{0.788}$ $In_{0.238}$ to $Sc_{0.758}$ $In_{0.242}$ become ferromagnetic below 6°K. Values of Tc deduced from Curie—Weiss plots and saturation magnetization measurements agree well; values of μ_a do not. Neither a band filling mechanism leading to itinerant electron ferromagnetism nor localized d-electrons provides a satisfactory explanation of the data. M.A.Taylor

12527 ON THE MAGNETIC ANISOTROPY OF SINGLE CRYSTAL OF CHROMIUM TELLURIDE.
T.Hirone and S.Chiba.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1991-4 (Nov., 1960).
The anisotropy of a ferromagnetic single crystal of CrTe with NiAs structure was investigated by magnetic torque measurements. From the experiment it was seen that the axis of easy magnetization is [001] and it does not change from room temperature to liquid He temperature. At 0°K the uniaxial anisotropy constant will be about 5×10^6 erg cm^{-3}. As for the origin of anisotropy, the dipole—dipole energy can account for only about 20% of the observed value.

12528 MAGNETIC ANISOTROPY OF COBALT AS REVEALED BY ELECTRON DIFFRACTION. S.Yamaguchi.
J. appl. Phys. (USA), Vol. 32, No. 5, 961-2 (May, 1961).

The thermomagnetic anisotropy of a cobalt crystal is revealed by means of an electron diffraction process, in which the electron beam is used to heat the object, to study the Lorentz effect by magnetic analysis, and to determine its crystallographic orientation.
C.A.Hogarth

12529 MAGNETIC ANISOTROPY AND ROTATIONAL HYSTERESIS IN SINGLE CRYSTALS OF MAGNETITE BELOW THE TRANSITION TEMPERATURE.
R.F.Pearson and R.Cooper.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 17-24 (July, 1961).

Torque curves were obtained at 82°K on gallium- and aluminium-substituted single crystals of magnetite. The paper consists of two parts, one dealing with the values of the constants required to describe the intrinsic anisotropy of Fe_3O_4 below the crystallographic transition and the other concerned with the irreversible nature of the torque curves observed on some of the gallium-substituted crystals. A model based on the ordering of Fe^{2+} and Fe^{3+} ions is proposed to explain this rotational hysteresis which occurs in higher fields than would be necessary for magnetic saturation.

12530 MAGNETIC ANISOTROPY IN SINGLE-CRYSTAL NICKEL FILMS. J.C.Anderson.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 25-32 (July, 1961).

Single-crystal thin films of nickel, in the thickness range 50-500 A were prepared, by epitaxial growth on rock-salt, and their magnetic anisotropy measured. All films show a uniaxial anisotropy superposed on the normal cubic anisotropy. In the discontinuous films, annealing in vacuum reduces the uniaxial component whilst in continuous films annealing increases it. Films grown in a vacuum of 10^{-7} mm Hg are found to have few imperfections visible in the electron microscope and give more consistent results. The uniaxial component of anisotropy is shown to be a function of thickness, and is affected by the degree of vacuum achieved during deposition. It is suggested that the mechanism of directional ordering of oxygen atoms in the metal lattice, as proposed by Heidenreich, Nesbit and Burbank (Abstr. 8310 of 1959) would account for the results.

12531 MAGNETIC AND ELECTRICAL ANOMALIES OF IRON TELLURIDE SINGLE CRYSTALS.
R.Naya, M.Murakami and E.Hirahara.
J. Phys. Soc. Japan, Vol. 15, No. 2, 360-1 (Feb., 1960).

Reports measurements of susceptibility, magnetization and electrical conductivity of $FeTe_x$ ($x = 0.8, 0.95, 1.10$-1.15). The crystals with $x < 1$ show anomalies at about 260°C, which are ascribed to an ordering of excess Fe atoms on the tetragonal Fe—Fe lattice. E.P.Wohlfarth

12532 MEASUREMENT OF REVERSIBLE MAGNETIC SUSCEPTIBILITY IN THE PRINCIPAL CRYSTALLOGRAPHIC DIRECTIONS OF A NICKEL–IRON CRYSTAL.
S.S.Fonton.
Kristallografiya (USSR), Vol. 5, No. 2, 325-7 (March-April, 1960). In Russian.

Results are quoted for the initial magnetic susceptibility at liquid nitrogen temperature of three crystals of 94% Fe, 5.5% Ni, 0.5% impurities. The specimens were all cut out from a parent crystal of meteoric origin into frames with sides parallel to [100], [110] and [111] type of directions, respectively, and measurements were made by a ballistic method. The three specimens had an initial susceptibility close to 15. A graph was also plotted for the ratio of reversible to initial susceptibility against relative magnetization and the result is discussed in terms of domain wall displacements. It appears that in the reversible region 90° domain wall movements predominate. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 306-8 (Sept.-Oct., 1960)].
R.Parker

12533 MAGNETIC ANNEALING OF Co AND Co–Ni ALLOYS. M.Takahashi and T.Kōno.
J. Phys. Soc. Japan, Vol. 15, No. 5, 936-7 (May, 1960).

The uniaxial magnetic anisotropy constant, K_u was measured in pure cobalt and in nickel—cobalt alloys, by comparing torque curves obtained from specimens annealed in a magnetic field with those annealed in the absence of a magnetic field. For nickel-rich Co—Ni alloys without phase transitions the torque is of the same order of magnitude as for Ni—Fe alloys. For cobalt-rich Co—Ni alloys it is extremely large. In the γ-phase region, the variation of K_u is proportional to $C_a^2C_b^2$ where C_a and C_b are the concentrations of nickel and cobalt respectively. S.A.Ahern

12534 "MEMORY" OF INITIAL REMANENT MAGNETIZATION AND NUMBER OF REPEATING OF HEAT TREATMENTS IN LOW-TEMPERATURE BEHAVIOUR OF HAEMATITE.
T.Nagata, M.Yama-ai and S.Akimoto.
Nature (GB), Vol. 190, 620-1 (May 13, 1961).

Synthetic haematite powders were subjected to cooling—heating cycles between liquid nitrogen and room temperatures. The thermoremanent and isothermal remanent magnetization intensities did not recover their original values before the cooling—heating cycle. The thermoremanent intensity was smaller the larger the magnetizing field, while the isothermal intensity behaves oppositely. The intensity corresponding to any even number of cycles was generally larger than that corresponding to the two nearest odd numbers of cycles. This phenomenon was confirmed up to 55 heating cycles.
D.S.Parasnis

12535 MAGNETOSTRICTION AND CRYSTAL ANISOTROPY OF NICKEL—CHROMIUM AND NICKEL—VANADIUM ALLOYS. T.Wakiyama and S.Chikazumi.
J. Phys. Soc. Japan, Vol. 15, No. 11, 1975-81 (Nov., 1960).

Magnetostriction constants, λ_{100} and λ_{111}, were measured at room and liquid nitrogen temperatures by a strain gauge method. Both constants were negative and their magnitudes decreased monotonically with increasing the composition of adding element. Magnetocrystalline anisotropy constants were also measured at the same temperatures. The concentration dependence of the anisotropy constants was more drastic than that of the magnetostriction constants. The present data and other available data of nickel binary alloys are analysed on the basis of Néel's theory and the coefficients of dipole—dipole and quadrupole—quadrupole interactions of atom pairs in Ni alloys are estimated. The dipole—dipole interactions of Ni—M (where M = V, Cr, Mn, Fe, Co, Ni and Cu) atom pairs are fairly well explained under the assumption of the spin—orbit interaction.

12536 PREFERRED DIRECTIONS IN SECONDARY RECRYSTALLIZED TAPES WITH 50% Ni AND Fe.
E.Adler and H.G.Baer.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 190-6. In German.

According to Rathenau and Custers [Philips Res. Rep. (Netherlands), Vol. 4, 241 (1949)] several textures occur in secondary recrystallized tapes with 50% Ni and 50% Fe. One of them [(102)-texture] is magnetically favourable, others are more or less unfavourable. Normally the unfavourable components predominate and little or no magnetic directional preference is observed. New recent investigations on secondary recrystallized tapes of alloys with 50% Ni and 50% Fe have shown that under certain conditions pronounced rectangular hysteresis loop with a $B_r : B_s$ ratio of about 0.90 can be obtained. The material has only one preferred orientation, namely the (102). The magnetically unfavourable components are lacking. Conditions for the appearance of these special textures, especially the influence of the tape thickness, are discussed.
D.S.Parasnis

12537 TEMPERATURE DEPENDENCES OF THE WIDTH OF THE RESONANCE CURVE AND THE RELAXATION PROCESSES IN SINGLE CRYSTALS OF FERRITES.
A.G.Gurevich, I.E.Gubler and A.G.Titova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 19-31 (Jan., 1961). In Russian.

The width of the resonance curve and the magnetic susceptibility at resonance were measured over the temperature range from −196°C to the Curie point, for the Y-ferrite (yttrium iron garnet) and for the Mn- and Mg-Mn ferrites with spinel type structures. The specimens were in the form of spheres with various degrees of surface polish. The Y-ferrite spheres were obtained from single crystals grown from the oxide with various degrees of purity. Conclusions are made concerning various relaxation processes and the temperature dependences of the contributions to the width of the resonance curve $2\Delta H$, determined by these processes. It is shown that the contribution to $2\Delta H$, connected with the roughness of the surface of the specimens, is approximately proportional to the magnetization. The contribution to $2\Delta H$ determined by the non-coherent relaxation processes near the Curie point, is approximately proportional to $1/(T_c-T)^{\frac{1}{2}}$, where T_c is the Curie temperature. In the case of the Y-ferrite, the relaxation frequency of the ions of the rare-earth admixtures was determined. [English translation in: Soviet Physics – Solid State (USA)]. N.I

538 THE DISPERSION MECHANISMS IN LITHIUM FERRITE. A.A.Fomenko.
F tverdogo Tela (USSR), Vol. 3, No. 2, 328-30 (Feb., 1961).
In ...ssian.
...Voigt, published a paper containing experimental values of the r... rsible magnetic susceptibility of $LiFe_5O_8$ over a wide range o... equencies. (See Abstr. 8127 of 1958). Fomenko accepts these r... lts but disagrees with the conclusions drawn from them by V... t concerning the mechanism of the magnetization processes ir... is substance. Fomenko draws different conclusions, particul... about the dominant part played by reversible displacements ... main boundaries in the radio-frequency range with low constant ... H, and the major role played by rotational processes in the ... high-frequency range. [English translation in: Soviet P... ics—Solid State (USA), Vol. 3, No. 2, 236-7 (Aug., 1961)].
N.Davy

2539 ULTRASONIC MEASUREMENT OF MAGNETIZATION IN Mn-FERRITE SINGLE CRYSTAL.
...simi, K.Nishiguchi and T.Suzuki.
...ys. Soc. Japan, Vol. 15, No. 7, 1341 (July, 1960).
The ultrasonic technique for examining ferroelectric polariza... without disturbing the domain configuration (Abstr. 3426 of 1959), ... odified to the case of magnetic materials. This is possible ...use of the dependence of magnetostriction on magnetization. A ... y is made of the magnetization switching process in a Mn ... ite crystal, for various pulse amplitudes and pulse widths.
K.N.R.Taylor

2540 TIME DECREASE OF MAGNETIC PERMEABILITY IN SOME MIXED FERRITES. K.Ohta.
...hys. Soc. Japan, Vol. 16, No. 2, 250-8 (Feb., 1961).
The time decrease of the magnetic permeability after de... gnetization, or disaccomodation, was measured for Mn—Zn, ...-Zn, Cu—Zn and Mg—Zn ceramic ferrites. Considerable dis... omodation was observed with samples containing Fe_2O_3 over the ...chiometric composition. In the case of Mg—Zn ferrites, the ...ccomodation is remarkable on both sides of the stoichiometric ...position, where it is fairly small. For the specimens sintered ...ir, the disaccomodation is larger for higher electrical-con... tive specimens, while such a correlation to the conductivity dis... eared after the specimens were annealed in the nitrogen atmos... re. A single crystal of Ni—Zn ferrite, which is supposed to ...tain a very small number of vacancies, also shows a very small ...ccomodation. The activation energy determined from dis... omodation measurements is about 0.5-0.8 eV for Mg—Zn ...rites. It is suggested that the displacement of either vacancies ...interstitial ions may possibly be the main origin of the phenom... n.

12541 THERMODYNAMIC AND MAGNETIC PROPERTIES OF YTTERBIUM IRON GARNET.
...Henderson and R.L.White.
...s. Rev. (USA), Vol. 123, No. 5, 1627-30 (Sept. 1, 1961).
Some low-temperature thermodynamic and magnetic properties ...YbFe garnet are calculated as functions of temperature and ...entation of the magnetization. The calculation is based on the ...ctroscopically determined splittings of the ground-state doublets ...he ytterbium ions. The calculation accounts for the principal ...tures of the observed torques and specific heats. It predicts a ...mpensation point in the magnetization near 7.7°K which has since ...n observed. It also predicts a temperature change accompanying ...adiabatic rotation in a saturating magnetic field.

12542 MAGNETIC AND CRYSTALLOGRAPHIC STUDY OF NEODYMIUM-SUBSTITUTED YTTRIUM AND ...DOLINIUM IRON GARNETS.
...eller, H.J.Williams and R.C.Sherwood.
...ys. Rev. (USA), Vol. 123, No. 5, 1692-9 (Sept. 1, 1961).
A study of the garnet systems $\{R_{3-x}Nd_x\}Fe_2Fe_3O_{12}$, R ≡ Y or ..., indicates, as expected, that the moment contributed by the ...$^{3+}$ ion adds to that of the resultant contributed by the ...olattices, similar to the results of earlier work by others on ...ermetallic systems involving rare earths and also on Nd- and ...-substituted YFe garnets. This is explained on the basis that in ... L—S ions Nd and Pr, $\vec{J}$ is generally directed oppositely to $\vec{S}$. ...is found that the anisotropy introduced by the Nd^{3+} ion prevents ...uration at applied fields up to 14 000 Oe, and at first a null ...ethod involving the garnet system $\{Gd_{2-x}Y_xNd\}Fe_2Fe_3O_{12}$ was used ...find the moment contributed by the Nd^{3+} ion at 0°K; the moment ...tained by this method is 1.2 μ_B. Subsequently, measurements ...de to fields of 80 000 Oe at 4.2°K on the garnets $\{Y_2Nd\}Fe_2Fe_3O_{12}$ and $\{Gd_2Nd\}Fe_2Fe_3O_{12}$ proved that the extrapolation of n_B versus $1/H_a$ to $1/H_a = 0$ from the lower field values did not give the proper moments for these compounds. The specimens appeared to be saturated at fields above 70 000 and 60 000 Oe, respectively, and gave moments of 6.2 μ_B and 7.7 μ_B, respectively, per formula unit. These values indicate moments for the Nd^{3+} ion of 1.2 μ_B and 1.3 μ_B, respectively. These values corroborate that found by the aforementioned compensation point method. The low value contrasted with the ground-state gJ value of 3.27 μ_B indicates a considerable crystal field effect on the Nd^{3+} ion in the garnets. Maxima have been found for amounts of Nd substitution in Y, Gd, and Sm iron garnets. These data in turn lead to prediction regarding maximum substitution of Nd in other rare-earth iron garnets and also predict a maximum lattice constant close to 12.538 A for any iron garnet, indicating that Pm iron garnet would not exist. Data are given also on some other garnets used to strengthen these conclusions. The garnet $Gd_{1.5}Nd_{1.5}Ga_2Ga_3O_{12}$ may be antiferromagnetic but with a Neel temperature below 1.4°K. Magnetic and crystallographic data are also given on the garnets $\{Gd_{1.5}Er_{1.5}\}Fe_2Fe_3O_{12}$ and $\{Y_{1.5}Er_{1.5}\}Fe_2Fe_3O_{12}$, both of which lead to 5.4 μ_B for the Er^{3+} ion contribution at 0°K, in good agreement with the value deduced from Pauthenet's measurements on erbium iron garnet.

12543 FERROMAGNETIC ALIGNMENT BY ANTIFERROMAGNETIC EXCHANGE INTERACTION. NOTE ON THE MAGNETIC BEHAVIOR OF NEODYMIUM GARNET. W.P.Wolf.
J. appl. Phys. (USA), Vol. 32, No. 4, 742-3 (April, 1961).
Explains how in rare earth ions with a less than half-filled f-shell the g-factor is positive so that antiparallel alignment of these spins with respect to another sub-lattice gives rise to parallel magnetic moments. This principle is used to explain the change of moment of YIG on the addition of Nd. D.J.Oliver

12544 FERRIMAGNETISM OF Mn_5Ge_2.
K.Yasukōchi, K.Kanematsu and T.Ohoyama.
J. Phys. Soc. Japan, Vol. 15, No. 5, 932 (May, 1960).
The spontaneous magnetization of Mn_5Ge_2 decreases to zero at 395°K, increases again to a maximum at 630°K, and then reduces to zero again at 710°K. The reversal of the sign of the spontaneous magnetization was demonstrated in a separate experiment.
D.J.Oliver

12545 SCATTERING OF SLOW NEUTRONS IN FERRIMAGNETIC CRYSTALS. J.Kociński.
Acta phys. Polon. (Poland), Vol. 19, No. 6, 691-9 (1960).
Cross-sections for scattering of slow neutrons by spin waves in ferrimagnetic crystals were calculated. The type of ferrimagnetics with spins pointing in the same direction at absolute zero temperature was treated. The formula for the scattering cross-section given by Halpern and Johnson (Abstr. 3008 of 1939) for the ferromagnetic case was generalized to lattices with two kinds of spins. By means of it the cross-sections for various scattering processes were calculated in the manner used by Maleev (Abstr. 5207 of 1958) in the ferromagnetic case.

12546 HELICAL ANTIFERROMAGNETISM.
A.Herpin, P.Meriel and J.Villain.
J. Phys. Radium (France), Vol. 21, No. 1, 67 (Jan., 1960).
In French.
Suppose in a crystal lattice there is a system of parallel planes in which atoms in the same plane are strongly coupled ferromagnetically but in which atoms in successive planes are at an angle θ, it can be shown that a stable state exists if the interaction between next nearest planes is sufficiently strong. $MnAu_2$ is such a material with $\theta = 51°$. The properties have been studied with the aid of neutron diffraction. D.J.Oliver

12547 ON THE MAGNETIC PROPERTIES OF Cr_2As AND Cu_2Sb. M.Yuzuri.
J. Phys. Soc. Japan. Vol. 15, No. 11, 2007-12 (Nov., 1960).
The thermomagnetic properties of the compounds Cr_2As and Cu_2Sb were investigated together with the phase diagram of Cr—As system. From the results of thermal and thermomagnetic measurements for Cr_2As and Cu_2Sb it was found that they show antiferromagnetic behaviour with the Néel point at 393° and at 373°K respectively. Their reciprocal susceptibilities obey the Curie—Weiss law in high temperature range, but a considerable deviation therefrom is seen just above the Néel point. From the Curie constant obtained by the present experiment, the effective magneton number μ_{eff} of the magnetic carrier was calculated to be 3.6 and 2.6 for these compounds, Cr_2As and Cu_2Sb, respectively. The total

heat absorptions due to the vanishing of antiferromagnetic order in spin arrangement were 50 Cal/mol and 20 Cal/mol. A discussion is given on the origin of the above-mentioned magnetic properties.

12548 MAGNETIC PROPERTIES OF POTASSIUM IRON GROUP FLUORIDES KMF_3.

K.Hirakawa, K.Hirakawa and T.Hashimoto.

J. Phys. Soc. Japan, Vol. 15, No. 11, 2063-8 (Nov., 1960).

Evidence of antiferromagnetism in the perovskite-type potassium iron group fluoride KMF_3 was found through the susceptibility measurements made between 80° and 700°K. The obtained results are as follows:

Compounds	T_N(°K)	θ (°K)	C_M	p
$KMnF_3$	88	158	4.73_5	6.15
$KFeF_3$	113	-	-	-
$KCoF_3$	114	125	3.07_5	4.95
$KNiF_3$	275	843	2.41_5	4.39
$KCuF_3$	243	355	0.58_7	2.16

T_N: Néel point, θ: paramagnetic Curie temperature,

C_M: Curie constant, p: effective Bohr-magneton number.

Additional thermal analysis was also made in order to confirm the Néel points. The magnetic properties of these compounds are reviewed and brief discussions of the results are given.

12549 MAGNETIC ANISOTROPY OF CHROMIUM ANTIMONIDE AND ITS MANGANESE SUBSTITUTES.

I.Tsubokawa.

J. Phys. Soc. Japan, Vol. 16, No. 2, 277-81 (Feb., 1961).

The magnetic anisotropy of compounds of CrSb, $(Cr_{0.9}Mn_{0.1})$ Sb and $(Cr_{0.8}Mn_{0.2})$ Sb was investigated by using their single crystals. From the measurements of torque curves by means of a torsion pendulum magnetometer, the difference between the susceptibilities parallel and perpendicular to the c-axis of the hexagonal crystal lattice was obtained for each specimen. It was confirmed that the magnetic spin axis lies along the c-axis for each compound. (also in the ferrimagnetic region of $(Cr_{0.8}Mn_{0.2})$ Sb). The magnetic anisotropy constant K of CrSb was estimated to be about 10^5 erg gm^{-1} at room temperature.

MAGNETIC SUSCEPTIBILITY OF MATERIALS USED IN CRYOGENIC APPARATUS. See Abstr. 11869

Magnetic Resonances

12550 NONLINEAR DAMPING LOSSES IN YIG. R.L.Conger.

J. appl. Phys. (USA), Vol. 32, No. 8, 1525-7 (Aug., 1961).

High-power ferromagnetic resonance in a flat plate has a small component of the precession parallel to the applied d.c. field. This component causes frequency doubling and also coherent amplification of some scattered spin waves. These spin waves then cause a linear damping of the parallel component of the precession, which in turn causes a nonlinear damping of the principal component of the precession. The nonlinear damping causes the microwave susceptibility to decrease with increasing power and to become approximately inversely proportional to the r.f. field at high power levels.

12551 EFFECT OF CHEMISORBED HYDROGEN ON THE FERROMAGNETIC RESONANCE OF FINELY DIVIDED NICKEL. D.P.Hollis and P.W.Selwood.

J. chem. Phys.(USA), Vol. 35, No. 1, 378-80 (July, 1961).

The line width, g value and line shape do not change, but the signal amplitude decreases as hydrogen is absorbed.

M.A.Taylor

12552 THEORY OF FERRO- AND ANTIFERROMAGNETIC RESONANCE ABSORPTION. T.Oguchi and A.Honma.

J. Phys. Soc. Japan, Vol. 16, No. 1, 79-94 (Jan., 1961).

The resonance conditions are obtained by the spin–wave theory. According to the usual free spin–wave theory, the resonance frequency is independent of temperature and has only the value $\omega(0)$ at 0°K. The spin–wave interactions give the correct temperature dependence for the resonance frequency. As a result of including these interactions, the ferromagnetic resonance condition, taking account of the anisotropy energy, agrees with the Kittel's formula (Abstr. 1273 of 1948). For the cases of the ferromagnet resonance including the demagnetizing effect, and the antiferromagnetic resonance, however, the resonance conditions obtained high temperatures agree with the formulae of Kittel (Abstr. 6347 1951) and Nagamiya (Abstr. 1111 of 1952) and Keffer–Kittel (Abstr. of 1952) respectively, but at low temperatures the conditions show a ent temperature dependence from their formula. However, this new theoretical result is not in agreement with the experimental data in MnF_2 by Jaccarino–Shulman (Abstr. 7322 of 1958) and Johnson–Nethercot (Abstr. 2419 of 1957).

12553 SPIN–SPIN RELAXATION TIME IN FERROMAGNET J.Morkowski.

Acta phys. Polon. (Poland), Vol. 19, No. 6, 701-10 (1960).

Spin–spin relaxation time caused by pseudo-dipolar coupling between spins is calculated. It appears that for spin waves excit in ferromagnetic resonance in metals, having wave vector magni tudes of the order of inverse skin-depth, the relaxation time is determined practically by processes of splitting one spin wave in two (and confluence of two into one) only, leading to a time of the order of magnitude 10^{-8} sec for nickel (at room temperature and magnetic field strength of about 5000 Oe).

12554 STUDY OF A SINGLE CRYSTAL OF YTTRIUM GARN IN A FERRIMAGNETIC RESONANCE EXPERIMENT HIGH POWER. J.Hervé and M.Sauzade.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 331-6 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). For previous work, see Abstr. 6253 of 1960.

12555 FERRIMAGNETIC RESONANCE IN POLYCRYSTALLI EUROPIUM–IRON GARNET ($Eu_3Fe_5O_{12}$).

Y.Shichijō, T.Miyadai and H.Takata.

J. Phys. Soc. Japan, Vol. 15, No. 3, 530 (March, 1960).

The g-value and linewidth were measured in the temperature range from –196° to +300°C. The g-value becomes as small as 1.27 at low temperatures and increases almost linearly to 1.48 at 300°C. The linewidth has a minimum of about 800 just below the Curie point and rises to 5000 Oe at low temperatures. However, the evaluation of the linewidth at low temperatures is complicated by the appearance of a second resonance line which is attributed having the effective anisotropy field larger than the saturation magnetization as explained by Schlömann (Abstr. 13858 of 1960).

P.E.Sei

12556 FERRIMAGNETIC RESONANCE IN EUROPIUM-IRON GARNET. T.Miyadai.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2205-10 (Dec., 1960).

Ferrimagnetic resonance experiments in a single crystal and polycrystalline samples were carried out by a usual microwave technique. It was found, for the single crystal, that the temperature variations of the g-factor and the line width are similar to th of erbium–iron garnet (ErIG) except for the existence of a broad maximum in line width at about 200°K. These behaviours agree well with Kittel's theory proposed recently (Abstr. 1820 of 1960). At room temperature, $g_{eff} = 1.32$, $\Delta H = 600$ Oe (anisotropy in line width being hardly observed) and $K_1/M_S = -400$ Oe (which is an order of magnitude larger than that of YIG). For polycrystalline samples, g_{eff} is essentially the same as for the single crystal sample. In the absorption curve, a secondary peak appeared, bel 200°K, in the lower magnetic field side of the main absorption peak. The electronic state of Eu^{3+} in the garnet crystal is briefly discussed.

12557 ANTIFERROMAGNETIC RESONANCE IN NiO IN FAR INFRARED REGION. H.Kondoh.

J. Phys. Soc. Japan, Vol. 15, No. 11, 1970-5 (Nov., 1960).

Using the far-infrared spectrometer constructed recently in Osaka University, measurements of the optical absorption were m on the single crystal of NiO (Néel temperature = 523°K) in the wa length range of 210 to 385 microns and at temperatures 90° to 47 No magnetic field was applied. An absorption peak was clearly observed whose wavelength varied with temperature. With increa ing temperature it shifted toward the longer wavelength side and the same time the peak height diminished. At room temperature (291°K) the peak was at 293 ± 5 microns (34.1 ± 0.6 cm^{-1}) and th wavelength value extrapolated to absolute zero was 274 microns (36.5 cm^{-1}). This absorption peak is attributed to the antiferromagnetic resonance of the mode in which the antiparallel sublatti magnetizations oscillate perpendicularly to the easy plane of

gnetization, (111). The constant, K, of the anisotropy energy ich constrains the sublattice magnetizations in the easy plane is culated to be 4.96×10^6 erg cm^{-3} at 0°K from the theoretical mula

$$\omega = (ge/2mc)(2K/\chi_\perp)^{1/2},$$

suming g = 2.23. This can be compared with the theoretical ue, 7.01×10^6 erg cm^{-3}, based on the magnetic dipolar inter- ion between Ni^{2+} ions, but the experimental value is smaller.

12558 SPIN RESONANCE IN NEUTRON-IRRADIATED GRAPHITE. K.A.Müller.

ys. Rev. (USA), Vol. 123, No. 5, 1550-2 (Sept. 1, 1961).

The carrier spin-resonance line of neutron-irradiated single ystals of graphite at 300°K was observed as a function of the ermal neutron flux up to a dose of 9.6×10^{18} nvt. From the ensity increase and the g shift for H parallel to the c-axis, it concluded that on the average 30 holes become mobile per nvt r cm^3. This is in agreement with the work of Hennig and Hove 955) which was based on electrical measurements. It is shown at the line they reported in spin-resonance experiments on poly- ystalline graphite was due to mobile charge carriers and not to ramagnetic carbon centres as they assumed. The number of holes eated is compared to a recent electron transmission microscopy vestigation of Bollmann (Abstr. 7610 of 1961) where the damage is observed directly. It is estimated that about one hole per splaced carbon atom is freed. For the unirradiated graphite the iewidth was found to be anisotropic, being 4.6 G for H parallel d 3.0 G for H perpendicular to the c-axis. This shows for the st time an incomplete "motional" narrowing for mobile carrier in resonance. The anisotropy as well as the width decreases onotonically with irradiation, and at the highest dose investigated e linewidth is isotropic and equal to 1.3 G. The change in line- idth with irradiation and temperature is interpreted as due to a ange in spin—lattice relaxation time T_1 which is caused by carrier attering via spin—orbit interaction.

12559 INTERACTION EFFECTS IN $K_3Fe(CN)_6$. T.Ohtsuka.

Phys. Soc. Japan, Vol. 15, No. 5, 939-40 (May, 1960).

In the paramagnetic resonance spectrum of $K_3Co(CN)_6$ contain- g about 5% Fe^{3+}, lines have been observed due to isolated pairs interacting iron ions. The anisotropic exchange interaction etween the ions in two such types of pair was measured and com- ared with specific heat and Weiss constant measurements (Abstr. 426 of 1957). Consistency is obtained only if one assumes that ach Fe^{3+} ion has two nearest neighbour sites rather than six as ggested by the crystal structure J.M.Baker

12560 MAGNETIC RESONANCE IN $MnCO_3$. M.Date.

Phys. Soc. Japan, Vol. 15, No. 12, 2251-4 (Dec., 1960).

The magnetic resonance of the single crystal of $MnCO_3$ was vestigated using microwave frequencies 9 to 36 kMc/s. Parasitic rromagnetic resonance was observed at 4.2°K which can be xplained by the theory of magnetic resonance developed for α-Fe_2O_3 Motizuki and Pincus (Abstr. 16153 of 1960). The effective field DM due to the Dzyaloshinsky—Moriya interaction (Abstr. 8286 of 959; 11902 of 1960) was obtained to be 3.7 K Oe and the other esonance constant $\sqrt{2H_E H_A}$ to be 1.4 K Oe, where H_E is the xchange field and H_A the anisotropy field in the basal plane.

12561 A PARAMAGNETIC SPECIES IN IRRADIATED $NaNO_2$. H.Zeldes and R.Livingston.

chem. Phys. (USA), Vol. 35, No. 2, 563-7 (Aug., 1961).

Single crystals of sodium nitrite were irradiated with Co^{60} mma-rays at 77°K and studied by the paramagnetic resonance ethod. An anisotropic three-line hyperfine spectrum associated ith a single paramagnetic species was observed. The hyperfine ructure arises from a nitrogen nucleus in the paramagnetic species a position of mm point symmetry. The principal values of the g nsor and the hyperfine tensor were deduced as well as the direc- ons of their principal axes. The paramagnetic species is believed be NO_2.

12562 ELECTRON SPIN RESONANCE IN [GAMMA] IRRAD- IATED POLYTETRAFLUOROETHYLENE: DECOM- OSITION OF THE COMPLEX SPECTRUM. N.Tamura.

Phys. Soc. Japan, Vol. 15, No. 5, 943-4 (May, 1960).

Discusses some phenomena not reported by Rexroad and Gordy bstr. 5909 of 1959) in their similar study. The complex spectrum bserved is explained as the superposition of spectra originating om at least three types of radical. J.M.Baker

12563 TRANSITIONS AND RELAXATIONS IN POLYTETRA- FLUOROETHYLENE. R.K.Eby and K.M.Sinnott.

J. appl. Phys. (USA), Vol. 32, No. 9, 1765-71 (Sept., 1961).

The modulus and internal friction of polytetrafluoroethylene were measured with longitudinal waves at a frequency of 12 Mc/s between 248° and 548°K and the fluorine magnetic resonance was studied between 77° and 375°K. The samples covered a wide range of crystallinities and included a specimen which had not been sintered (as polymerized material which had not been heated above the melting temperature). The results resolve discrepancies which exist in the literature and introduce new information about the relaxations and first-order transitions in polytetrafluoroethylene. In the ultrasonic work it is shown that the "19°C" and "30°C" diffuse first-order crystalline transitions can be studied independently of the crystalline relaxation which occurs at 418°K at 12 Mc/s. The "19°C" transition is not observed but the "30°C" transition causes an appreciable decrease in the modulus. X-ray data show that this accompanies a decrease in the rotational order of the lattice. This transition is found to occur over a wider temperature range in unsintered polymer (possibly because of a distribution of the lengths of the molecular segments in the ordered regions). An NMR absorption line from the crystalline regions is resolved and its narrowing above 280°K is attributed to rotational motions associated with the first-order transitions. Comparison with published data shows that the narrowing occurs over a wider temperature range in unsintered polymer. Consideration of a distribution of relaxation times suggests that the narrowing above 190°K of an NMR absorption line from the amorphous regions results from the molecular motion which gives rise to a relaxation observed at 263°K in the ultrasonic measurements. Another amorphous relaxation is observed at 470°K in the ultrasonic measurements and the activation parameters are obtained. Examination of these parameters for the two relaxations suggests that the higher-temperature relaxation should be assigned to the larger molecular segments. For all the relaxations, the parameters follow a relation which obtains for activated processes in inorganic solids.

12564 NUCLEAR SPIN—LATTICE RELAXATION FOR THE CASE OF SPIN 1 OR ½. V.S.Grechishkin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1066-7 (April, 1961). In Russian.

The generalization of the formulae of Bayer is carried out for the cases of nuclear spin 1 and ½. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 776-7 (Oct., 1961)]. E.A.Sanderson

12565 SPIN—LATTICE RELAXATION IN IMPERFECT CUBIC CRYSTALS AND IN NON-CUBIC CRYSTALS. E.R.Andrew and D.P.Tunstall.

Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 1-11 (July, 1961).

An examination is made of the spin—lattice relaxation in the solid state of nuclei whose energy level spacings in a magnetic field are rendered unequal by quadrupole interactions with the crystal-line electric field. Attention is directed to two special cases: (1) when the main magnetic field is suddenly increased from zero, and (2) after saturation of the central line of the resonance spectrum; in the case of imperfect cubic crystals this is the only observed line. In general, 2I relaxation times characterize the relaxation behaviour, though in the two special cases the effective number is reduced. Detailed calculations of the relaxation behaviour were made for spin number $\frac{3}{2}$ and $\frac{5}{2}$ for a quadrupolar relaxation mechanism. The behaviour in the two special cases differs and to a degree which depends on the relative strength of quadrupolar relaxation by transitions involving $\Delta m = 1$ and 2. The relevance of the results to the experiments of Day and Squire(Abstr. 4533 of 1960) on potassium iodide is discussed. Magnetic relaxation is also treated and an expression is found for the 2I relaxation times.

12566 SPIN—LATTICE RELAXATION IN CEROUS MAGNE- SIUM NITRATE. R.P.Hudson and R.S.Kaeser.

Nuovo Cimento (Italy), Vol. 19, No. 6, 1275-7 (March 16, 1961).

Measurements were made of the complex magnetic susceptibility of cerous magnesium nitrate in the temperature interval 1.64° to 2.12°K. The results were analysed in terms of the Cosimir—Du Pré theory. Above 2°K the relaxation time, τ, appears to be determined mainly by a transition between the ground and first excited doublet which involves two phonons. The level separation is 26 cm^{-1} (phonon sum 36°K). Below 2°K other mechanisms become significant and the results are analysed in terms of a "Raman-type" second order process. By analogy with relaxation mechanisms in paramagnetic salts it is suggested that a "direct" relaxation process may become dominant in turn below 1.6°K. The

values of τ calculated from the measurements are fitted as a function of temperature by an expression which takes into account all three transitional modes. P.J.Dean

12567 APPLICATIONS FOR AN N.M.R. SPECTROMETER USING WEAK FIELD. I. DOUBLE IRRADIATION OF THE AMMONIUM ION. II. THE BLOCH-SIEGERT EFFECT.
H.Benoit and H.Ottavi.
Arch.Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 691-5 (1960).
In French.

9th Colloque Ampère Paper (See Abstr. 4734 of 1961). A short note calling attention to previous work by the authors (Abstr. 1066b, 12672 of 1960). W.J.Orville-Thomas

12568 NUCLEAR MAGNETIC RESONANCE STUDIES OF B^{11} IN CRYSTALLINE BORATES.
P.J.Bray, J.O.Edwards, J.G.O'Keefe, V.F.Ross and I.Tatsuzaki.
J. chem. Phys. (USA), Vol. 35, No. 2, 435-42 (Aug., 1961).

The coordination state of the boron atom in boron compounds may be correlated with the properties of the nuclear magnetic resonance (NMR) signals arising from the boron nuclei. Characteristic resonance line shapes occur when the NMR transitions are perturbed by interactions between the B^{11} nuclear electrical quadrupole moment and the electric field gradient at the boron site. In polycrystalline borates, boron in trigonal and tetrahedral coordination may be resolved by analysis of first and second-order quadrupolar effects on the NMR transitions. The B^{11} quadrupole coupling constants were measured for the simple trigonal BO_3 and tetrahedral BO_4 groups. The analysis was extended to include polyborate structures having both trigonal and tetrahedral boron atoms. Results of the NMR study of simple, known bonding configurations are discussed and correlated with measurements of alkali-borate glasses and of miscellaneous borate and mineral compounds.

12569 NUCLEAR RESONANCE IN METALLIC COBALT POWDERS. G.Berthet and J.Dupuis.
Arch. Sci. (Switzerland), Vol 13, No. Fasc. Spec., 422-4 (1960).
In French.

9th Colloque Ampère Paper (See Abstr. 4734 of 1961). The authors report that, using a self-oscillating detector, they have been unable to detect the Co^{60} nuclear magnetic resonance in powders consisting of a mixture of cubic and hexagonal cobalt.
E.F.W.Seymour

12570 HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE SPECTRA OF DIPHOSPHINE AND MONOPHOSPHINE.
R.M.Lynden-Bell.
Trans Faraday Soc. (GB), Vol. 57, Pt 6, 888-92 (June, 1961).

The spectra of the phosphorus and hydrogen nuclei of diphosphine were analysed as an A_2X_4 system with effective symmetry C_{2v}, and the coupling constants determined. For comparison, the coupling constants of monophosphine were found by deuteration. The spectrum of diphosphine is consistent with relatively rapid interconversion between two skew forms of the molecule.

12571 NUCLEAR DYNAMIC POLARIZATION IN IRRADIATED POLYTETRAFLUOROETHYLENE. G. Hardeman.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 669-73 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The dynamic polarization of F^{19} in polytetrafluoroethylene irradiated by electrons of 1 MeV energy was studied for different concentrations of paramagnetic centres. W.J.Orville-Thomas

12572 PROTON MAGNETIC RESONANCE OF ICE SINGLE CRYSTAL. K. Kume and R.Hoshino.
J. Phys. Soc. Japan, Vol. 16, No. 2, 290-2 (Feb., 1961).

The single crystal of ice was examined by proton magnetic resonance method, and the result was shown to be consistent with Pauling model. The problem of whether the arrangements of protons is ordered or not is, however, still open to the question.

12573 NUCLEAR QUADRUPOLE RESONANCE AND ELECTRON SPIN RESONANCE IN $C(NH_2)_3Al(SO_4)_2.6H_2O$ AND ISOMORPHOUS COMPOUNDS. G.Burns.
Phys. Rev. (USA), Vol. 123, No. 5, 1634-44 (Sept. 1, 1961).

The temperature dependence of the nuclear quadrupole coupling parameters, eQq/h, of Al and Ga was measured in the ferroelectric compound $C(NH_2)_3Al(SO_4)_2.6H_2O$ (GAlSH) and three other isomorphous compounds that result when Ga replaces Al and SeO_4 replaces SO_4. Measurements were also made on deuterated GAlSH. The temperature dependence of the electron spin resonance of Cr^{3+}, substituted for Al or Ga in the above five compounds, was also measured. For the five compounds, eQq/h versus temperature for each compound was similar, small (~100 kc/s), linear with tem- ature, and in some cases changed sign. Within the framework o the ionic model, eQq/h and d(eQq/h)/dT were calculated. It is f that the latter is fairly insensitive to the X-ray and charge distribution parameters and depends mainly on the large anisotropic thermal expansion coefficient. Using the theoretically calculate antishielding factor, there is agreement between the calculated the measured d(eQq/h)/dT. The data also indicate that the ratio the antishielding factors of Al^{3+} and Ga^{3+} are in approximate ag ment with the calculated values. The temperature dependence o the electron spin resonance of Cr^{3+} in the five compounds is aga similar to each other. The g values for the Al and Ga compounc are the same within experimental error. The zero-field splittin (D term in the spin-Hamiltonian) of the deuterated GAlSH has a slightly larger variation with temperature than the undeuterated compound. By parametrically eliminating temperature, the rela between D and eQq/h is studied. The result is two parallel lines one for the two different sites in the two Al compounds and the o for the Ga compounds. The lines are parallel only if the Ga nuc quadrupole moment and antishielding factor are normalized to t of Al. Using simple crystal field theory, it is shown that D shou be proportional to eQq/h. However, the data show that D and eQ are not simultaneously zero and that the slope is ten times large than calculated. These two discrepancies are discussed. A calculation of the extra potential seen by the 3d electrons, due t fact that the crystal field induces a quadrupole moment in the co electrons, is discussed. However it does not remove the discre ancy. It appears that the relation between D and the crystalline field is not firmly established.

12574 RESEARCHES ON THE QUADRUPOLE RESONANCE NITROGEN. L.Guibé.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 657-60 (1960).
In French.

9th Colloque Ampere Paper (see Abstr. 4734 of 1961). Reso ance frequencies were measured at –196°C and –74°C for piperi urea, thiourea, 4-picoline and pyridine, covering the region 500- 4000 Mc/s. Piezo-electric resonances were eliminated by using powdered specimen or by immersion in a non-resonating liquid. Pyridine lines have 4 components, attributed to four different sites in the crystal lattice; preliminary measurements were ma with single crystals. G.F.Lot

12575 A NUCLEAR QUADRUPOLE DOUBLE RESONANCE EXPERIMENT. L.Guibé.
C.R. Acad. Sci. (France), Vol. 252, No. 12, 1762-4 (March 20, 19
In French.

In 4-picoline the asymmetry of the electric field gradient is large that transitions were observed by Guibe (see preceding abst between the levels A and B of the spin 1 states:

A, $E = (1 + \eta)\,k$;
B, $E = (1 - \eta)\,k$;
C, $E = -2\,k$.

Each of the resonances was studied in turn while a saturating fie was applied to another transition. The results obtained are anal in terms of maser theory. (See also Abstr. 1181 of 1957).
S.A.Al

12576 NUCLEAR QUADRUPOLE RESONANCE UNDER HIG PRESSURE I. T.Fuke.
J. Phys. Soc. Japan, Vol. 16, No. 2, 266-77 (Feb., 1961).

The nuclear quadrupole resonance frequencies of I^{127} in sta tetraiodide (SnI_4), of As^{75} in arsenolite (As_4O_6), of Br^{81} in paradibromobenzene ($p\text{-}C_6H_4Br_2$) and in potassium bromate ($KBrO_3$) w measured as a function of hydrostatic pressure at various temp atures. The pressure range was 1-9000 kg cm^{-2} in the tempera range from –77° to 100°C, and 1-1000 kg cm^{-2} at liquid oxygen temperature, respectively. In general, the pressure and the tem ature dependence of the resonance frequency is found to agree w Bayer theory (Abstr. 1170 of 1952) incorporated with Kushida–Benedek–Bloembergen's theory (Abstr. 2804 of 1957). It is noti however, that an anisotropic change of the internal parameters the positions of atoms in a unit cell would contribute appreciably to the analysis of the data even in the cases of cubic crystals, S As_4O_6 and that a deviation from the Bayer curve is observed in As_4O_6. Doublet lines for SnI_4 are found to behave differently as function of volume, and it is concluded for the molecular crystal As_4O_6 that the effective modes of lattice vibration which are res ponsible for the temperature dependence of the resonance frequ are intra-molecular modes rather than a tipping mode of the molecule as a whole.

MECHANICAL PROPERTIES OF SOLIDS

2577 ELASTIC PROPERTIES OF SHORT CYLINDRICAL RUBBER SAMPLES. W.Erler.
ıfrequenztech. u. ElektAkust. (Germany), Vol. 69, No. 5, 170-9 ., 1960). In German.
An elastometer is described for measuring the elastic modulus loss factor of cylindrical rubber specimens of different ension ratio at frequencies up to 1000 c/s and results are ed for two rubbers. The equipment is capable of measuring ı very low loss factors with an accuracy of about 1%.
H.J.H.Starks

2578 VOLUME VISCOELASTICITY OF POLYMERS AND OTHER HIGHLY DISSIPATIVE MATERIALS.
ada, H.Hirose, H.Umebayashi and M.Otomo.
hys. Soc. Japan, Vol. 15, No. 12, 2324-34 (Dec., 1960).
A new method for determining the real and imaginary parts of : modulus of polymers and other solid materials is represented. method, called "suspension method", consists of measurements ound velocity and attenuation in a suspension of powders and is erior in experimental accuracy to the existing method which ntially consists of the comparison of longitudinal and shear e measurements. The new method has also a merit in its licability to the sample in powdery state. The results are given styrene–butadiene rubber, natural rubber, polyethylene, ypropylene, polytrifluoromonochloroethylene, paraffin and yeast ., among which styrene–butadiene rubber is most fully investi- ed. From these results, the following is concluded. In the nary dispersion of amorphous polymers, the relaxation strength f the same order of magnitude for bulk and shear moduli. reover, relaxation times, and their distribution and temperature endences have no appreciable discrepancy between two moduli. he case of crystalline polymers, the mechanical dispersions are e different between the powder samples which have undergone no atment after polymerization and the ones moulded from the der.

QUANTITATIVE DETERMINATION OF THE DYNAMIC STRESS NDITIONS IN TRANSVERSELY IMPACTED BENT BEAMS TH THE AID OF SPARK CINEMATOGRAPHY AND [PHOTO- ASTIC] STRESS OPTICS. See Abstr. 11720

12579 ELASTICITY RELAXOMETER FOR MEASUREMENTS OF HIGHLY ELASTIC DEFORMATIONS, STRENGTH D RELAXATION OF COLLOIDAL SYSTEMS. A.A.Trapeznikov.
bory i Tekh. Eksper. (USSR), 1958, No. 3, 93-6 (May-June). Russian.
Two rotating cylinder devices for use with highly elastic tems are described, and illustrative data obtained on 2% minium naphthenate gel in decalin are given. [English transla- n in: Instrum. exper. Tech. (USA), No. 3, 423-6 (May-June, 8; publ. June, 1959)].
R.F.S.Hearmon

12580 THE B.A.M. STRAIN TRANSFER DEVICE, DESIGNED BY FEUCHT; A NEW ANCILLARY UNIT FOR THE .M. PFENDER EXTENSIOMETER SYSTEM. W.Feucht.
titute of Physics Stress Analysis Group Conference, Delft, 1959 e Abstr. 10455 of 1961) p. 9-19. In German.
The device is designed to allow the indirect measurement of ains over gauge lengths of 20 and 10 mm when space is restricted; extensometer itself is primarily designed for direct measure- nt on a gauge length of 100 mm which is marked by 1/16 in. el balls pressed into the test piece, the extensometer being d against and set to read the distance between the spheres. The ain transfer devices are small extensometers with one fixed and one adjustable tubular leg that may be clamped, but without icator. The transfer device is first applied to the station marked the steel balls, adjusted to length and clamped, after which it is noved from the specimen and the extensometer is applied to it, hout loss of accuracy. As a practical novelty, in cases where the al application of 1/16 in. steel balls for marking the gauge gth is impracticable, adhesive "ball strips" have been developed; se are paper strips on which 1/16 in. hemispheres have been ached previously at the required distance.

12581 AN AUTOMATIC STRAIN-MEASURING DEVICE. H.Wieringa.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 24-7.
The main reason for the development of this instrument was the automatic and very fast measurement of strain by means of wire-resistance strain gauges at a large number of measuring points. The basis of measurement is a compensation method by a double Wheatstone bridge. One of these bridges is formed by the strain gauges. 48 of these strain-gauge bridges are connected to a separate connecting box and then measured automatically in succession. This connecting box has the advantage that the wiring to the 48 points can be kept short, whilst at the same time the measuring box itself can be placed at a large distance. If necessary more boxes can be connected, so that a large number of points can be measured. Read-out is made possible by an analogue-to-digital converter which gives the measured strain in decimal form on an electrical type-writer. The measuring time for reading 48 points is about 3 min.

12582 ESTIMATION OF DYNAMIC MODULUS AND DYNAMIC YIELD STRESS FOR "PERSPEX". J.Roberts.
Nature (GB), Vol. 190, 799-800 (May 28, 1961).
The dynamic Young's modulus for Perspex was estimated by a method based on the measurement of the time for which a steel ball remained in contact with a plate of Perspex during bouncing. The result (5.3×10^{10} dynes cm^{-2}) compares favourably with those obtained by other workers. An attempt was made to estimate the dynamic yield stress from consideration of the size of the electro-statically charged patch left by the impact of the ball; the value obtained was 16.9×10^{8} dynes cm^{-2}.
D.M.Schlapp

12583 ELASTIC CONSTANTS OF CsBr, CsI, RbBr, AND RbI. K.Reinitz.
Phys. Rev. (USA), Vol. 123, No. 5, 1615-19 (Sept. 1, 1961).
The elastic constants of two body-centred halides, CsBr and CsI, were determined as a function of temperature from 300° to 73° K. The ultrasonic velocity measurements were obtained with an interferometer constructed according to the design principles of Williams and Lamb. Room temperature constants of RbBr and RbI samples were also measured. The values of C_{11}, C_{12}, and C_{44} in units of 10^{11} d/cm^2 at 22° C for these salts are:

	C_{11}	C_{12}	C_{44}
CsBr	3.097	0.903	0.7500
CsI	2.434	0.636	0.6316
RbBr	3.15	0.493	0.384
RbI	2.54	0.407	0.276

The temperature dependence of all the Cs salt constants was negative and nearly linear over the temperature range investigated. It was found that with decreasing temperatures C_{44} increased more rapidly than C_{12} for the two Cs salts examined. The elastic constant data of the NaCl type halides, compiled from the literature, are compared with those of the CsCl type salts.

12584 CHANGE OF MECHANICAL PROPERTIES OF NICHROME ON FORMATION OF THE K-STATE.
G.V.Starikova and A.A.Presnyakov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 6, 943-5 (Dec., 1960). In Russian.
The anomalous rise of the electrical resistance on annealing of Nichrome after quenching is known as the K-state. The authors report that the tensile strength of Nichrome was not greatly affected by low-temperature annealing, but a 400-500°C anneal raised the strength by 6% compared with the strength of hardened non-annealed Nichrome. Annealing at 600-700°C lowered the tensile strength again. The rise of the tensile strength may be related to formation of the K-state and its subsequent fall (above 500°C) may be due to destruction of this state.
A.Tybulewicz

12585 STRUCTURAL FATIGUE UNDER COMBINED SINUSOIDAL AND RANDOM VIBRATION.
H.R.Spence and H.N.Luhrs.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1098-101 (Aug., 1961).
Structural fatigue caused by combined sinusoidal and random vibration is of concern in flight proofing of electronic equipment, since such excitation occurs in many current ballistic missile equipments. How to predict the fatigue under this vibratory excitation is discussed with particular reference to the relationship of combined vibration to a single sinusoidal substitute. Equations and curves for obtaining the sinusoidal substitute are presented and their application illustrated on a single resonator system.

12586 SOME REMARKS ON HYDROSTATIC PRESSURE AND MAXWELL MODEL. W.Segawa.
J. Phys. Soc. Japan, Vol. 16, No. 2, 317-19 (Feb., 1961).

The difference between the hydrostatic pressure and the isotropic component of the stress tensor was mentioned by Reiner in his theory of dilatancy [Amer. J. Math., Vol. 67, 350 (1945)]. In the recent development of the theory of viscoelasticity, however, it seems that this distinction becomes less apparent. In this paper, this distinction is rigorously discussed in relation to Maxwell model. It is shown that as far as it is assumed that actual stress is equivalent to elastic stress and also to viscous stress, and the condition that viscous stress vanishes when the viscous strain rate becomes zero, derived Maxwell's formulas can not contain hydrostatic pressure.

12587 RHEOLOGICAL EQUATIONS OF GENERALIZED MAXWELL MODEL AND VOIGT MODEL IN THREE-DIMENSIONAL, NON-LINEAR DEFORMATION. W.Segawa.
J. Phys. Soc. Japan, Vol. 16, No. 2, 320-3 (Feb., 1961).

It is well known that the generalized Maxwell and Voigt models are very useful for description at the mechainical behaviours of materials having a distribution of relaxation times or retardation times, as far as the deformation of the materials is one-dimensional and the strain and the strain rate are sufficiently small. In this paper, these two models are extended so as to be applicable to three-dimensional and nonlinear deformations of initially isotropic materials and two sets of rheological equations corresponding to each of such extended models are obtained. It is also shown that, the condition of small deformation being introduced, each of the two sets are reduced to three-dimensional extensions of the corresponding classical equations, and moreover, the three-dimensionaly extended formulae, which are appled to simple elongation, are reduced to the corresponding classical (one-dimensional) equations for the case of simple elongation.

12588 EFFECT OF RADIATION ON MECHANICAL PROPERTIES OF IONIC CRYSTALS. B.V.Budylin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2484-6 (Oct., 1960). In Russian.

Microhardness and elastic limit of NaCl, NaBr, KCl and KBr monocrystals rose after irradiation in a nuclear reactor. The changes in mechanical properties increased with increase of the total dose (10^{16}–10^{18} neutrons/cm^2) and with increase of the crystal lattice energy. [English translation in: Soviet Physics—Solid State (USA), Vol. 2, No. 10, 2214-16 (April, 1961)]. A.Tybulewicz

12589 THE STATE OF STRESS IN NOTCHED RODS AND ITS EFFECT ON THE CREEP AND THE APPROACH TO BRITTLE FRACTURE OF STEELS.
A.Kochendörfer and A.Schürenkämper.
Institute of Physics Stress Analysis Group Conference, Delft, 1959 (see Abstr. 10455 of 1961) p. 88-91. In German.

12590 ON THE POSSIBILITY OF THE DETERMINATION OF PLASTIC DEFORMATION WITH THE HELP OF A GEIGER POINT COUNTER. J.Mader and B.Sujak.
Acta phys. Polon. (Poland), Vol. 19, No. 2, 179-85 (1960). In German.

Studies of exo-electron emission from samples of aluminium stimulated by white-light illumination are reported. It is found that the emission decays less rapidly in the neighbourhood of regions of the specimen which have been subjected to plastic deformation by compression. Two interpretations of the effect are put forward: (a) in terms of the production of emission centres in the interior of the sample, which then diffuse to the surface, and (b) in terms of changes in the cohesive energy of the surface layer due to deformation. Experiments in which the plastic deformation of a polymer in the dark causes changes in its state of electrification are also described. C.H.B.Mee

12591 MICRO- AND MACROPLASTICITY AND FAILURE OF POLYCRYSTALS. F.P.Rybalko.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 597-603 (Oct., 1960). In Russian.

Describes a study of the non-uniformity of the distribution of plastic deformation in polycrystalline aluminium in terms of a microscopic theory. A.Tybulewicz

12592 THE DEPENDENCE OF THE DAMPING DECREMENT ON THE AMPLITUDE OF ELASTIC VIBRATIONS AND A STUDY OF PLASTIC DEFORMATION OF OVERSTRESSED MICRO-REGIONS. R.I.Garber and I.I.Soloshenko.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 6, 934-7 (Dec., 1960). In Russian.

Changes of the damping decrement show that the hardening of crystals (by plastic deformation) at large vibration amplitudes does not preclude hardening at small vibration amplitudes. For each stress there is a set of weak points which can be cured by plastic deformation. A.Tybulewicz

12593 PLASTIC DEFORMATION OF TEXTURED BERYLLIUM.
V.M.Amonenko, G.F.Tikhinskii, V.A.Finkel', V.M.Azhazha and I.V.Shpagin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 796-802 (March, 1961).

A method is described for producing Be foil by condensation in vacuum from the vapour on Mo sheet. The texture of the Be depends on the conditions of deposition, on the texture of the Mo sheet, and on its previous history. From extensional tests the least and most probable slip directions are determined, and the ultimate strength, extension and lateral contraction are shown as functions of temperature between 20° and 800°C. [English translation in: Soviet Physics — Solid State (USA), Vol. 3, No. 3, 580-(Sept., 1960)]. R.F.S.Hearn

12594 THE DISCONTINUOUS NATURE OF PLASTIC DEFORMATION AT LOW TEMPERATURES.
I.A.Gindin, B.G.Lazarev and Ya.D.Starodubov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 920-5 (March, 1961). In Russian.

The stress—strain diagrams in compression and tension of 25 metals at temperatures between 1.4° and 77°K were investigat and results are given for Al, Fe, Li, Na, Ni, Pb, Hg, Cs, and U. all cases the plastic flow shows a discontinuous character. Poss reasons for the discontinuities are discussed, including mechanic twinning, polymorphic transitions and relaxation processes. [Eng translation in: Soviet Physics — Solid State (USA), Vol. 3, No. 3, 669-73 (Sept., 1961)]. R.F.S.Hearn

12595 NONBASAL GLIDE IN DISLOCATION-FREE CADMIUM CRYSTALS. I. THE (10$\bar{1}$1) [1$\bar{2}$10] SYSTE
P.B.Price.
J. appl. Phys. (USA), Vol. 32, No. 9, 1746-50 (Sept., 1961).

Electron-transparent dislocation-free platelets of cadmium were deformed in tension parallel to the basal plane, inside an electron microscope, in the temperature range from +25° to −15 At high strain rates the crystals twinned. At low strain rates ($<\sim 10^{-2}$ sec^{-1}) the glide system depended on α, the angle betwee the tensile axis and a close-packing direction. For $0 \leq \alpha < \sim 20°$ pyramidal glide on the (11$\bar{2}$2) [$\bar{1}$1$\bar{2}$3] system occurred. For $30° \geq \alpha > \sim 20°$ a new glide system, (10$\bar{1}$1) [1$\bar{2}$10], was identified which has not yet been observed in large cadmium crystals. Edg dislocations with a $\frac{1}{3}$[1$\bar{2}$10] Burgers vector moved across the enti crystal on (10$\bar{1}$1) planes without multiplying or forming obstacles further glide. Occasionally, at high strain, fracture occurred on (10$\bar{1}$1) plane. The observations suggested that, in the temperatur range studied, the flow stress for (10$\bar{1}$1) [1$\bar{2}$10] glide was considerably lower than that for prismatic glide on the (10$\bar{1}$0) [1$\bar{2}$ system, slightly higher than that for (11$\bar{2}$2) [$\bar{1}$1$\bar{2}$3] glide, and independent of strain for a given temperature.

12596 NONBASAL GLIDE IN DISLOCATION-FREE CADMIUM CRYSTALS. II. THE (11$\bar{2}$2) [$\bar{1}$1$\bar{2}$3] SYSTEM. P.B.Price.
J. appl. Phys. (USA), Vol. 32, No. 9, 1750-7 (Sept., 1961).

The (11$\bar{2}$2) [$\bar{1}$1$\bar{2}$3] glide system was studied in thin, dislocati free cadmium platelets by transmission electron microscopy and compared with observations on zinc platelets. Screw dislocation with a $\frac{1}{3}\langle\bar{1}1\bar{2}3\rangle$ Burgers vector were formed at the edges of the crystal and moved primarily on {11$\bar{2}$2} planes. Elongated, sessil dislocation loops were formed on basal planes when screws developed large jogs during cross-glide. Smaller numbers of secondary $\frac{1}{3}\langle\bar{1}1\bar{2}0\rangle$ dislocations were also formed and moved on basal planes. Observations in the temperature range −150° to +25°C showed that the behaviour of the long loops and of the othe dislocations in cadmium and zinc varied with temperature as follows: (1) At temperatures lower than ~−120° in Cd and ~−80 in Zn, the long loops were stable and practically no recovery too

e. High densities of loops and networks of secondary dislocations
built up and hardened the crystal. (2) In the intermediate
erature range −120° to −40° for Cd and −80° to + 10° for Zn, the
loops split up into rows of circular loops, which were then
le. The process involved the pipe-diffusion of material
nd the long loops and required a lower activiation energy than
for climb. Some of the circular loops were found to contain
king faults. (3) At high temperature, above ~−40° for Cd and
)° for Zn, circular loops annealed out by climb with an
vation energy ~ 0.8 eV for Cd and ~ 0.95 eV for Zn; secondary
ocation networks dispersed by climb; and the dislocation density,
therefore the work-hardening, was small. At high beam
nsities dislocation loops often grew by climb, probably as a
lt of the formation of point defects by ion bombardment, the ions
g formed by the interaction between electrons and residual gas
ecules.

2597 SLIP PATTERNS ON BORON-DOPED SILICON SURFACES. H.J.Queisser.
ppl Phys. (USA), Vol. 32, No. 9, 1776-80 (Sept., 1961).
Diffusion of a high concentration of boron impurities into a
low surface layer of silicon and subsequent etching reveals
ılar arrays of etched lines with crystalline symmetries. These
erns are interpreted as slip lines introduced by the stress from
nonuniformly distributed, undersized substitutional boron
urities in the silicon lattice.

12598 WORK-HARDENING OF HEXAGONAL CLOSE-PACKED CRYSTALS AND IN THE EASY GLIDE REGION OF CE-CENTRED CUBIC CRYSTALS.
eeger, H.Kronmüller, S.Mader and H.Träuble.
l. Mag. (GB), Vol. 6, 639-55 (May, 1961).
Collects the available evidence from work-hardening curves,
)-line observations, and ferromagnetic measurements on the
y glide region of f.c.c. metals and alloys and the low-temper-
re work hardening of hexagonal metals. New experimental
ults are reported on copper single crystals deformed at liquid
gen temperature. A dislocation theory of work hardening is
en which accounts rather well for the experimental facts. The
k-hardening rate can be calculated from slip-line data (distances
ween and lengths of slip lines) and is found to agree well with the
asurements. The theory is a statistical one and is based on the
that in the deformation stage considered here the important
ess-fields are those of individual dislocations rather than those
iled-up groups. The present paper is another example for the
fulness of slip-line studies in theories of work-hardening.

AN EXAMPLE OF STRESS ANALYSIS WITHOUT STRAIN
ASUREMENTS. See Abstr. 11719

12599 THE EFFECT OF IMPURITIES ON THE TEMPERATURE AND TIME DEPENDENCES OF THE STRENGTH OF TALS. V.I.Betekhtin, S.N.Zhurkov and A.V.Savitskii.
. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 453-61
pt., 1960). In Russian.
The dependence of the lifetime under a load on the applied
ess and temperature was given by

$$\tau = \tau_0 \exp\left(\frac{U_0 - \gamma\sigma}{RT}\right)$$

aluminium, silver and solid solutions of aluminium with copper
magnesium, and of silver with aluminium. The above relation-
p was obeyed in a wide range of impurity contents. The quanti-
s U_0 and τ_0 (the binding energy and the frequency of atomic
rations in a crystal in the case of pure metals) were independent
he nature and concentration of impurities. The only parameter
ch was affected by alloying was a structural coefficient γ. The
endence of γ on the impurity concentration is reported.
A.Tybulewicz

12600 DEPENDENCE OF THE [TENSILE] STRENGTH ON THE DURATION OF APPLICATION OF A LOAD IN HIGH CUUM. S.N.Zhurkov, B.Ya.Levin and É.E.Tomashevskii.
. tverdogo Tela (USSR), Vol. 2, No. 9, 2066-9 (Sept., 1960).
Russian.
Experiments carried out at room and higher temperatures on
spex ("organic glass"), aluminium (up to 300°C) and silver
oride (up to 100°C) showed that in 10^{-5}-10^{-7} mm Hg vacuum the
sile strength fell exponentially with the duration of application of
onstant load, in the same way as in air. The tensile strength of
spex was reduced by vapours of oils used in the vacuum appara-
and by immersion in such oils. [English translation in: Soviet
ysics—Solid State (USA), Vol. 2, No. 9, 1853-5 (March, 1961)].
A.Tybulewicz

12601 STRENGTH OF BULK FUSED QUARTZ. W.B.Hillig.
J. appl. Phys. (USA), Vol. 32, No. 4, 741 (April, 1961).
The fracture stress of fused quartz specimens (0.5-3.0 mm diameter and 5-10 cm length) was measured and many specimens failed at a fracture stress far greater than the theoretical maximum stress required to pull the atoms apart, estimated by Frenkel (1926) to be 0.2 times the Young's modulus E. The authors conclude that vitreous silica must be the strongest known bulk substance, only certain whiskers being stronger. R.Bullough

12602 ORIENTATIONAL DEPENDENCE OF SLIP AND RUPTURE IN BERYLLIUM SINGLE CRYSTALS IN TENSION. R.I.Garber, I.A.Gindin and Yu.V.Shubin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1144-51 (April, 1961).
In Russian.
The dependence on orientation of critical shear and rupture stresses and of relative extension is determined for Be specimens in tension at 20°C. The results are discussed in relation to the theory of critical normal stress and the normal and shear stresses existing at rupture. [English translation in: Soviet Physics — Solid State (USA), Vol. 3, No. 4, 832-7 (Oct., 1960)].
R.F.S.Hearmon

12603 GLASS CRACKING CAUSED BY UNDERWATER SPARK. S.Hyodo and F.Okuda.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2093-8 (Nov., 1960).
Using a Beckman and Whitley high-speed framing camera, the velocity of glass fracture caused by an underwater disruptive electric spark was measured. The observed maximum velocity was about 2.4 km sec^{-1}, 60% higher than the usually accepted normal limiting value. A gradual decrease of fracture velocity was also observed. From these observations it was deduced that the maximum fracture velocity is, contrary to the hitherto assumed theory, dependent on the increasing rate of applied stress.

12604 POSSIBILITY OF SUPERVELOCITY OF GLASS FRACTURE. S.Hyodo.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2351-3 (Dec., 1960).
Extrapolating the Glathart—Preston (Abstr. 1709 of 1946) equation for the variation of the glass strength with the loading time, it is assumed that, before a fracture is caused in soda-lime glass within the order of microseconds, the stress applied on it must have attained a value extraordinarily higher than the one for usual impacts — the difference in magnitude being nearly one order. From this assumption it is suggested that the local compression strain in soda-lime glass when subjected to impact by underwater sparks must surpass the ordinary linear elastic limit and accordingly that there may be a possibility of propagation of this fracture at a velocity higher than the normal limit.

12605 FEATURES OF THE DEVELOPMENT OF FRACTURE CRACKS IN SOLID POLYMERS.
M.I.Bessonov and E.V.Kuvshinskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 607-10 (Feb., 1960).
In Russian.
For abstract, see Abstr. 11325 of 1961. [English translation in: Soviet Physics — Solid State (USA), Vol. 3, No. 2, 445-7 (Aug., 1961)].

12606 THE FORMATION OF SUB-GRAIN STRUCTURE BY ALTERNATING PLASTIC STRAIN. J.Holden.
Phil. Mag. (GB), Vol. 6, 547-8 (April, 1961).
A micro-beam X-ray technique was applied to the fracture surfaces produced by slow-growing fatigue cracks. The cracks were propagated in metal sheets subjected to pulsating tension such that the rate of growth of the crack was proportional to its instantaneous length. The fracture surfaces showed a highly developed sub-grain structure with large misorientations $> 13°$. The sub-grain size was found to be independent of the range of cyclic stress used to propagate the crack and to be characteristic of the metal. The progressive development of the sub-grain structure was followed in torsion specimens subjected to large ranges of plastic strain ~ 10^{-2}. If the process of sub-grain formation is regarded as an essential feature of the mechanism of fatigue crack propagation then the order of susceptibility of metals to fatigue crack growth and the phenomenon of non-propagating surface cracks can be interpreted.

12607 THE KINETICS OF GROWTH OF "SILVER" CRACKS IN TRANSPARENT SOLID POLYMERS.
M.I.Bessonov and E.V.Kuvshinskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1314-23 (May, 1961).
In Russian.

The kinetics of the cracking produced by mechanical loading on the surface of polymethylmethacrylate and polystyrol is investigated and related to the creep and elastic properties of the materials. [English translation in: Soviet Physics — Solid State (USA)]. R.F.S.Hearmon

12608 FAILURE OF HARDENED STEEL UNDER COMPRESSION ALONG TWO DIRECTIONS.
O.P.Burmakina and F.S.Savitskii.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 609-16 (Oct., 1960). In Russian.

Failure of thin-walled hardened and tempered steel tubes confirmed a statistical theory put forward by Yagn (1931).
A.Tybulewicz

12609 THE RELATIVE HARDNESS OF THE HARD DIRECTIONS IN DIAMOND. E.M.Wilks.
Phil. Mag. (GB), Vol. 6, 701-5 (May, 1961).

A method is described of determining the relative hardness of the hard directions in diamond, using a micro-abrasion tester and diamond impregnated cutting wheels. Cube, dodecahedron and octahedron planes were studied and an order of hardness established between the various directions on these planes. This order of hardness should also apply for ordinary diamond polishing when loose diamond powder is used on a flat scaife, although in this case the differences in hardness are very much greater.

12610 LUBRICATION OF POLYMERS. C.Rubenstein.
J. appl. Phys. (USA), Vol. 32, No. 8, 1445-50 (Aug., 1961).

Previous work on the lubrication of polymers is reviewed and the explanations which have been advanced are examined and are shown to be inadequate. An alternative mechanism of polymer lubrication is proposed which is based on the hypothesis that when a lubricant is applied to a polymer it is possible for the lubricant molecules to penetrate the polymer and alter its mechanical properties. An investigation into the lubrication behaviour of textile polymers is described and an explanation of the results of this and other investigations is offered in terms of the proposed mechanism.

12611 FRICTIONAL BEHAVIOR OF A SIMPLE RHEOLOGICAL MATERIAL. R.T.Spurr.
J. appl. Phys. (USA), Vol. 32, No. 8, 1450-3 (Aug., 1961).

Simple experiments made on a hard bitumen support the adhesion theory of friction. The static friction of the bitumen depends upon its rheological properties, and for hemispherical specimens, μ_s is determined by the shear strength and flow pressure of the bitumen, the latter being obtained from indentation measurements. For nominally flat specimens, the time and temperature dependence of μ_s can be determined from indentation measurements. At low sliding speeds the dynamic friction can be related to the static friction, and to the rheological properties of the bitumen; at higher speeds frictional heating complicates interpretation of results.

12612 USE OF GRAPHITE WHISKERS IN A STUDY OF THE ATMOSPHERE DEPENDENCE OF GRAPHITE FRICTION. F.R.Rollins, Jr.
J. appl. Phys. (USA), Vol. 32, No. 8, 1454-8 (Aug., 1961).

Several physical properties of graphite whiskers were measured in ultra-high vacuum and other controlled atmospheres. The properties which were studied include elasticity, electrical resistance, and cohesion between whiskers. The atmosphere dependence of these properties suggests that surface adsorption of contaminants is the most important factor in producing changes in graphite friction. There is some evidence that the adsorbed gases reduce surface roughness on an atomic scale. This ability of the adsorbed film to smooth out surface asperities may be used to explain some of the friction and wear characteristics of graphite.

CRYSTALLOGRAPHY

12613 APPLICATION OF THE METHOD OF CHARGED POWDERS TO THE STUDY OF THE DOMAIN STRUCTURE AND MORPHOLOGICAL FEATURES OF THE GROWTH OF CRYSTALS OF TRIGLYCINE SULPHATE.
V.A.Meleshina, I.S.Zheludev and I.S.Rez.
Kristallografiya (USSR), Vol. 5, No. 2, 322-3 (March-April, 1960)
In Russian.

Specimens of Y-cut crystals, after polishing and cleaning th surface with alcohol, were immersed in a suspension of finely dispersed red lead oxide in carbon tetrachloride. When withdra from the solution the liquid evaporated leaving a powder pattern developed on the surface. Twinned (domain) structure was obse in various geometrical shapes together with growth pyramids. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 299-301 (Sept.-Oct., 1960)].

12614 ORIENTATION-DEPENDENT DISSOLUTION OF LITHIUM FLUORIDE. M.B.Ives.
J. appl. Phys. (USA), Vol. 32, No. 8,1534-5 (Aug., 1961).

It is shown that the etch rate of lithium fluoride crystals in both a modified CP-4 etchant and a dilute aqueous solution of ferr fluoride is a function only of crystallographic orientation. This conclusion is reached by comparing experimental observations with the results of a recent topographical theory of crystal dissolution.

12615 ETCH PITS IN ELECTROLUMINESCENT ZINC SULFIDE CRYSTALLITES. P.Goldberg.
J. appl. Phys. (USA), Vol. 32, No. 8, 1520-4 (Aug., 1961).

Through suitable etching techniques, triangular etch pits are developed on the surfaces of electroluminescent Zns:Cu,Cl powde crystallites at densities in the range 10^6-10^8 cm^{-2}. These pits, se by means of electron microscope, are essentially absent in similarly etched nonelectroluminescent ZnS:Cu,Cl crystallites. A present on the electroluminescent particles are surface striations The etch pits appear physically related to the striations in that the pits from only on those faces bearing the striations. All triangula pits on a given face point in the same direction which is normal to the striation direction. This direction is one of the crystallograph polar axes in sphalerite and the c axis in wurtzite. The pits have also been found in other electroluminescent compositions such as ZnS:Cu,Al; ZnS:Cu,Cl-Pb; and ZnS:Cu, Cl-Mn. The possible inter pretations of the pits and striations are discussed in terms of defe structures (e.g., dislocations and stacking faults) which may be of importance to the nature of the barriers believed to reside within the volume of electroluminescent particles. Some experiments wi large crystal specimens are reported.

12616 DISLOCATION ETCH PIT FORMATION IN SODIUM CHLORIDE. S.Mendelson.
J. appl. Phys. (USA), Vol. 32, No. 8, 1579-83 (Aug., 1961).

Dislocation etch pits can be formed on (100) surfaces of NaCl crystals by etching in a solution of $FeCl_3$ in glacial acetic acid. Observations and arguments are enumerated to illustrate the reliability of the etching technique to reveal dislocations at positions where they intersect the crystal surface. The difference in shape of etch pits at edge and screw dislocations is consistent wit that expected due to their different angles of inclination. Etch pit formation depends on variables of the etching solution and proceed Insufficient $FeCl_3$ in solution results in wide, indistinctly shaped pits, whereas excessive $FeCl_3$ results in small pits with rounded corners. NaCl in the solution decreases the etching rate, while th presence of water increases the etching rate and results in more shallow pits. The added salt in the solution is believed to act as inhibitor which poisons the dissolution process in the same manne as that proposed for LiF by Gilman et al. (Abstr. 4527 of 1958). Agitation increases the size of the pits for a given etching time.

12617 THERMAL ETCHING AND ANNEALING OF TWIN LAYERS IN CRYSTALS OF ANTIMONY.
F.F.Lavrent'ev, L.M.Soifer and V.I.Startsev.
Kristallografiya (USSR), Vol. 5, No. 3, 472-5 (May-June, 1960).
In Russian.

Twin layers of Sb, 5 to 20 μ in size, obtained by splitting on t (111) cleavage plane, were studied microscopically and by X-ray diffraction before and after annealing at 600° C. They were also

mined by thermal etching. It was found that annealing restored monocrystallinity of the specimen and that the twin boundaries the cleavage steps were both regions of intense thermal etching. presence of edge dislocations was deduced in the mother stal and in the twins, the dislocation lines being in the (11$\bar{1}$) ne. [English translation in: Soviet Physics—Crystallography A), Vol. 5, No. 3, 449-53 (Nov.-Dec., 1960)]. J.Thewlis

12618 RETENTION OF CARBON DIOXIDE BUBBLES ON CALCITE ETCH-PEAKS.
M.Dunlap and J.D.Wilkinson.
ture (GB), Vol. 190, 524-5 (May 6, 1961).

Calcite, etched in 0.001N hydrochloric acid for one week, veloped six-sided peaks; this is compared with previously re-rted data. On the etched calcite surface CO_2 bubbles nucleate and ow on the peaks of the etch figures; in place of the normal contact gle on uncleaved surface, these gas bubbles are connected at the rface by a gaseous stem. J.W.Taylor

12619 ETCH PITS ON CADMIUM-SULPHIDE CRYSTALS.
A.J.Eland.
ilips tech. Rev. (Netherlands), Vol. 22, No. 8, 266-7 (1960-61).

Two colour photographs are shown of the surface of a grown S crystal, etched in hydrochloric acid vapour and observed with nicroscope using interference contrast (magnification approx. 50). From the disposition of the etch pits it is probable that the ystal possesses a high degree of perfection: it apparently consists several large mosaic blocks, differing in their mutual orientation only a few seconds of arc.

12620 COMMENTS ON THE PAPER BY ALEKSANDROV, BERKIN, LIFSHITS AND STEPANOVA.
.Uaingard [W.C.Winegard].
iz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 637 ct., 1960). In Russian.

Aleksandrov et al. [Ibid., Vol. 2, 105 (1956)] reported a periodic ariation of the impurity density along a growing monocrystal. ecently, Landau (Abstr. 1882 of 1960) suggested that these varia-ons are due to periodic supercooling and consequent transitions om cellular to dendritic structure. The present author is of the inion that the most likely cause of the impurity variations lies fluctuations in the rate of growth produced by irregularities in e motion of the furnace or by cyclic temperature fluctuations. A.Tybulewicz

12621 DIAMOND—GRAPHITE EQUILIBRIUM LINE FROM GROWTH AND GRAPHITIZATION OF DIAMOND.
P.Bundy, H.P.Bovenkerk, H.M.Strong and R.H.Wentorf, Jr.
chem. Phys. (USA), Vol. 35, No. 2, 383-91 (Aug., 1961).

Diamond growth occurs at high temperatures and pressures in e presence of certain molten metals which serve as solvent talysts. The zones of pressure and temperature in which diamond owth occurs were determined for a number of metals. These nes are bounded on the low-temperature side by the melting point the metal—carbon eutectic at pressure. They are bounded on the gh-temperature side by the diamond—graphite equilibrium line. is experimentally determined equilibrium line agrees very closely th the theoretical extrapolation of the thermodynamically lculated line proposed by Berman and Simon, namely

$$P(\text{kbar}) = 7.1 + 0.027\,T\,(^{\circ}\text{K}).$$

12622 STUDIES ON THE PREPARATION OF PURE ALKALI CHLORIDES. K.Kobayashi and T.Tomiki.
Phys. Soc. Japan, Vol. 15, No. 11, 1982-90 (Nov., 1960).

Systematic studies were made on the preparation of pure KCl d NaCl crystals. Effects of the starting material on the purity the crystal were studied with KCl and NaCl powders of reagent ade of several different brands and with those prepared from carbonate and hydrochloric acid. Methods by distillation and ystallization in vacuum and by Kyropoulos technique in air were ed for the crystallization procedures to study their respective vantages. To estimate the concentration of impurities in crystals, e measurement of ionic conductivity was made for multivalent tallic ions, optical absorption for hydroxyl ions, and chemical alysis for bromine ions. The purest crystal in respect of these purities was found to be the one grown from its powder prepared om bicarbonate and hydrochloric acid by the method of distilla-on and crystallization in vacuum. After the studies on the edge of e fundamental absorption in connection with the concentration of romine, an absorption band due to the presence of bromine was und in KCl of which the maximum is at 7.12 eV at room tempera-re.

12623 NUCLEATION IN AGITATED SOLUTIONS.
J.W.Mullin and K.D.Raven.
Nature (GB), Vol. 190, 251 (April 15, 1961).

Work on nucleation and growth conditions in a pilot-scale Oslo crystallizer, operating with unseeded solutions of ammonium dihydrogen phosphate, confirms critical supersaturation to be dependent on the rate of circulation of the liquor (i.e. degree of turbulence); less supersaturation is required for nucleation to occur at the higher rates of flow. Whereas gentle stirring causes nucleation in solutions otherwise stable, and, when sufficiently vigorous increases this tendency, the transition is not continuous. It appears that an effect may operate in nucleation which impedes the growth of, or disrupts, the sub-nuclei and may predominate in certain circumstances. H.H.Hodgson

12624 X-RAY STUDIES ON PRECIPITATION OF METASTABLE CENTERS IN MIXED CRYSTALS NaCl—$CdCl_2$.
K.Suzuki.
J. Phys. Soc. Japan, Vol. 16, No. 1, 67-78 (Jan., 1961).

Mixed crystals NaCl—$CdCl_2$ containing a few mol.% of $CdCl_2$ were examined by an X-ray method. By a certain heat treatment, precipitates of a structure having a f.c.c. lattice, with lattice constant twice as that of the matrix, are formed within the matrix. By another heat treatment, there appear diffuse spots corresponding to the intensity distribution of rods extended to the directions of $\langle 100 \rangle$ at odd-order reciprocal-lattice points of the above mentioned structure. The crystal structure of the precipitates, which is identified to be $CdCl_2 \cdot 6NaCl$, are determined, and at the same time, the main features of the diffuse reflections are explained on the basis of the structure.

12625 CYCLIC TERMS OF ZINC OBTAINED AS MONO-CRYSTALS. D.Buttinelli and G.de Gregorio.
Ricerca sci. (Italy), Vol. 30, No. 5, 739-42 (May, 1960). In Italian.

Single crystals of zinc were temperature-cycled between 10° and 300°C. The velocity of recrystallization was found to depend markedly on the particular temperature range used and also on the mode of prepartion of the starting material. C.A.Hogarth

12626 FORMATION OF DIAMOND BY EXPLOSIVE SHOCK.
Science (USA), Vol. 133, 1821-2 (June 9, 1961).

Samples of graphite have been recovered after exposure to explosive shocks of 300 000 atm estimated intensity. X-ray and electron-diffraction examinations prove the existence of diamond in this material. The mechanism proposed for the formation of diamond under these conditions is simple compression in the c-axis direction of the rhombohedral form of graphite.

PREPARATION OF SINGLE-CRYSTAL THIN FILMS OF NICKEL AND NICKEL—IRON ALLOYS. See Abstr. 12664

CRYSTAL LATTICE STRUCTURES

12627 GROWTH OF WHISKER-CRYSTALS OF LITHIUM FLUORIDE. E.M.Nadgornyi.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 957-8 (March, 1961). In Russian.

An aqueous solution of LiCl + KF almost saturated with LiF was placed in a thin collodion or cellophane bag. Slow evaporation led to KCl crystallization on the exterior of the bag, and LiF whiskers on its inner surface in contact with the solution. These were usually 1-3 mm long and 1-5 microns across, with square or rectangular cross-section, although crystals up to 25 microns across were obtained, as also were platelets and irregular shapes. (see also Abstr. 9004 of 1959). [English translation in: Soviet Physics — Solid State (USA), Vol. 3, No. 3, 694 (Sept., 1961)]. C.H.L.Goodman

12628 AUTOMATIC SETTING AND REGISTRATION IN CONNECTION WITH X-RAY DIFFRACTOMETERS.
V.A.Vuster [W.A.Wooster].
Kristallografiya (USSR), Vol. 5, No. 3, 375-82 (May-June 1960). In Russian.

The design and operation of automatic diffractometers are described for both "normal beam" and "equi-inclination" systems. The first such instrument was that of Wooster and Martin in 1936, programmed by punched holes in 16 mm cine film. The diffracted

beam intensity was recorded by photographing a light-spot reflected from a galvonometer coupled to an ionization chamber. A modern version by Wooster in 1957 uses a Geiger–Müller counter for detection, punched teleprinter tape for control, and a different drive mechanism. The use of this instrument for powder diffraction, preferred orientation studies, and single crystal structure analysis is described. The Bond–Benedict equi-inclination diffractometer of 1955 is next described, which automatically seeks out each reflection. Finally, the Arndt–Phillips Linear-Traverse diffractometer, also equi-inclination, is described. This scans automatically along predetermined point rows of the reciprocal lattice. [English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 3, 355-61 (Nov.-Dec., 1960)]. R.V.Coates

12629 A CAMERA FOR THE STUDY OF DIFFUSE SCATTERING BY POLYCRYSTALS.
A.S.Kagan, V.A.Somenkov, and Ya.Umanskii.
Kristallografiya (USSR), Vol. 5, No. 3, 468-9 (May-June, 1960). In Russian.

A camera is described which gives stricter monochromatization and collimation than one for recording diffraction patterns, and in which air and slit scattering are removed. The incident radiation is monochromatized by reflection from a (111) plane of a germanium crystal; there is no second-order reflection, and the third-order is prevented by keeping the radiation-generating voltage below the appropriate excitation potential. The beam enters the camera via a celluloid window, and is collimated by slits of less than 0.5 mm width. A second celluloid window allows the unscattered beam to leave the camera. Lead foils remove air-scattered and slit-scattered radiation, and the camera interior is evacuated. The diffuse background can be measured between 8° and 45°. Operation was checked on fused quartz and copper, using Cu Kα radiation. The comparison of theoretical and practical curves is shown. [English translation in: Soviet Physics-Crystallography (USA) Vol. 5, No. 3, 445-7 (Nov.-Dec., 1960)]. R.V.Coates

A CRYOSTAT FOR USE AT LIQUID HYDROGEN AND HELIUM TEMPERATURES IN NEUTRON DIFFRACTION STUDIES.
See Abstr. 11865

12630 PSEUDOKINEMATICAL APPROXIMATION IN ELECTRON DIFFRACTION BY CRYSTAL. M.Hayashi.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2054-63 (Nov., 1960).

The pseudokinematical theory is considered to be a good approximation for gas molecules. When the theory is applied to crystals, however, there is an ambiguity concerning the nature of the approximation. In the present paper, the ambiguity is removed by comparing the result of the theory with the exact solution. The higher order Born approximation applied to the entire crystal is used as the exact solution. It is concluded that the pseudokinematical approximation is better than that of the usual kinematical theory and coincides almost with the exact solution under the condition that the crystal is very thin and there is no overlap of atoms when the crystal is seen from the direction of the incident beam.

12631 HIGH TEMPERATURE, HIGH VACUUM, DIFFRACTOMETER ATTACHMENT. J.Intrater and S.Hurwitt.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 905-6 (Aug., 1961).

Construction details are given of a high-temperature, high-vacuum diffractometer camera, which fits the Norelco wide-range goniometer.

12632 ELECTRON MICROSCOPY OF CRYSTAL LATTICES: AN ANOMALOUS EFFECT. L.T.Chadderton.
Nature (GB) Vol. 189, 564-5 (Feb. 18, 1961).

The conditions existing when a Bragg extinction contour lies across crystal lattice planes are considered, and the intensity distribution at the exit face of the crystal formulated. Terms in this equation represent the periodic intensity variations and the anomalous effect where the fringes lie at an angle to the true lattice plane direction. An electron micrograph illustrates the effect. V.R.Switsur

12633 ASPHERICAL 3d ELECTRON DISTRIBUTION IN BODY CENTERED CUBIC METALS. F.Stern.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 675-7 (June 15, 1961).

Estimates the asphericity of the 3d-electron atomic scattering factor for X-ray and polarized neutron diffraction; the results agree with neutron observations on iron. E.P.Wohlfarth

12634 A DIFFRACTION PATTERN CAUSED BY TEMPERATURE DIFFUSE SCATTERING. I. GENERAL TH
Y.Kainuma.
J. Phys. Soc. Japan, Vol. 16, No. 2, 228-41 (Feb., 1961).

When diffuse X-rays caused by scattering in a thermally vibrating crystal are scattered again in the same crystal, a ne diffraction pattern similar to Kossel-pattern is produced. The properties of the new pattern are discussed by the use of the pe urbation theory of X-ray scattering in a crystal. This discuss is similar to that given in the author's theory of Kikuchi-patter (Abstr. 5742 of 1955). According to the present theory, the sig of crystal structure factor can be determined by examining the pattern produced at an appropriate crystal orientation, provide relative values of elastic constants are available.

12635 THE THEORY OF NUCLEAR SCATTERING OF SL NEUTRONS IN ALLOYS.
V.M.Danylenko and Z.A.Matysina.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 743-50 (1958). In Ukrainian.

A formula is derived for the probability of neutron scatter due to concentrated heterogeneities for binary and ternary allo with hexagonal crystal lattices of the AB and AB_3 types. Both t long-range order and the correlation in the replacement of latt points by various kinds of atoms are taken into consideration.

12636 CONCERNING THE EVALUATION OF EXTINCTION COEFFICIENTS. V.M.Kardonskii.
Kristallografiya (USSR), Vol. 5, No. 3, 359-63 (May-June, 1960). In Russian.

A method is given for separating primary and secondary extinction effects in X-ray diffractometry (see Abstr. 813 of 19 It has been applied to find the crystallite size in ground and hea treated electrolytic nickel. [English translation in: Soviet Phy Crystallography (USA), Vol. 5, No. 3, 339-43 (Nov.-Dec., 1960)] A.R.S

12637 CONCERNING THE PRIORITY OF POPOV'S METH FOR THE DETERMINATION OF LATTICE PARAMETERS OF POLYCRYSTALLINE SUBSTANCES. I.P.Vyrodo
Kristallografiya (USSR), Vol. 5, No. 3, 467 (May-June 1960). In Russian.

It is pointed out that Popov gave a method for the determin of parallelogram nets for use in lattice parameter determinatio considerably before the publishing of the analogous method of de Wolff [Acta cryst. (Internat.), Vol. 11, Pt 9, 664 (Sept., 1958) He used the highest density planes which gave the maximum nu of orders of reflections in the X-ray patterns, and proposed to find the parallelopiped system by a nomogram method using tw binary quadratic forms. He presented graphs and tables for the construction of the nomograms, and proposed ways of using the method. [English translation in: Soviet Physics–Crystallogra (USA), Vol. 5, No. 3, 444-5, (Nov.-Dec., 1960)]: R.V.C

12638 ELECTRON DENSITY DISTRIBUTION IN GALLIUM ARSENIDE. N.N.Sirota and N.M.Olekhnovich.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 4, 879-81 (Feb. 1, 1961). In Russian.

X-ray diffraction intensity data (Cu K_α radiation) obtained 5-8 μ GaAs particles were used to evaluate atomic scattering factors. The electron density (D) throughout the unit cell was c culated by a method described previously (see Abstr. 13994 of 1 5016, 7865 of 1961). The minimum D between bonded Ga and As along [111] is 0.49 electrons/A^3 compared with 0.45 electrons/A^3 for InAs. D at the centre of As atoms is greater in GaAs than i InAs, which may be due to different Debye temperatures. At th 0.5 electrons/A^3 the contour radii are: Ga 0.8 A, As 1.65 A, and In 0.9 A, As 1.2-1.1 A; for 0.25 electrons/A^3 values are 1.3, 1.4 and 1.5, 1.35 A, respectively. As atoms are non-spherical. C.H.L.Goo

12639 OXYGEN POSITIONAL PARAMETERS OF TETRAGONAL Mn_3O_4. K.Satomi.
J. Phys. Soc. Japan, Vol. 16, No. 2, 258-66 (Feb., 1961).

The positions of the oxygen ions of tetragonal Mn O were determined through the Debye–Scherrer X-ray analysis, by the extension of the Bertaut's method [C.R. Acad. Sci. (France), Vol. 230, 213 (1950)].and with least square method. The assigne correction for the anomalous scattering on Mn to Fe–Kα radiat is somewhat larger than the calculated value. The two oxygen parameters ε and δ for the space-group D_{4h}^{19} are 0.032 ~ 0.036 and 0.008 ~ 0.010. These values correspond to the case that th tetragonal deformation comes from the octahedral sites but that the tetrahedral sites resist the deformation.

640 THE X-RAY DETERMINATION OF THE OXYGEN PARAMETER IN FERRITES WITH SPINEL STRUCTURE.
Bogoslovskii and A.A.Shchepëtkin.
Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 24-8 . 1960). In Russian.
The oxygen parameter in magnesium ferrite is determined by tterson function method and found to be equal to 0.375. The action pattern calculated from this value agrees satisfactorily experiment. R.F.S.Hearmon

641 X-RAY STUDIES ON THE FERRITE–HAEMATITE SOLID SOLUTIONS. C.Okazaki.
hys. Soc. Japan, Vol. 15, No. 11, 2013-17 (Nov., 1960).
The variation of the lattice dimensions of the solid solution em, $NiFe_2O_4$–Fe_2O_3, and the precipitation process of α-Fe_2O_3 efrom were investigated by X-ray analysis. These quenched d solutions possess unstable inhomogeneities originating in the lized oxidization. When annealed at certain temperatures, the d solution tends to become stabilized by the precipitation of e_2O_3. The activation energy for the precipitation was found to .03 eV. The solubility of Fe_2O_3 in $NiFe_2O_4$ was determined at ous temperatures, and the heat of dissolution was found to be eV.

2642 THE CRYSTAL STRUCTURE OF $KCuF_3$.
A.Okazaki and Y.Suemune.
hys. Soc. Japan, Vol. 16, No. 2, 176-83 (Feb., 1961).
The crystal structure of potassium trifluorocuprate (II) $KCuF_3$ determined by an X-ray analysis. The structure was refined he Fourier method. The crystals are tetragonal, with $\sqrt{2}a_0 = 5.855$ and $c = 2c_0 = 7.852$ A; space group D_{4h}^{18} – I4/mcm, four formula units ($KCuF_3$) in the unit cell, where a_0 and c_0 gnate the lattice constants of the fundamental pseudo-perovskite icture. This superstructure is due to a displacement of fluorine along the Cu–F–Cu bonds only in the c plane. The atoms are ie following positions: $4K^+$ in (a): $(0,0,0; \frac{1}{2},\frac{1}{2},\frac{1}{2}) + (0,0,\frac{1}{4}; 0,0,\frac{3}{4})$: $^{2+}$ in (d): $(0,0,0; \frac{1}{2},\frac{1}{2},\frac{1}{2}) + (0,\frac{1}{2},0; \frac{1}{2},0,0)$: $4F^-$ in (b): $(0,0,0;\frac{1}{2},\frac{1}{2},\frac{1}{2}) +$ $,\frac{1}{2},\frac{1}{4}; \frac{1}{2},0,\frac{1}{4})$: $8F^-$ in (h): $(0,0,0; \frac{1}{2},\frac{1}{2},\frac{1}{2}) \pm (x,\frac{1}{2}+x,0; \frac{1}{2}-x,x,0)$ $x = 0.228$. In this structure a Cu^{2+} ion is surrounded by a dis-ed octahedron of F^- ions with Cu–F distances of 2.25, 1.96 and A.

CRYSTALLOGRAPHIC STUDY OF NEODYMIUM-SUBSTITUTED TRIUM AND GADOLINIUM IRON GARNETS. See Abstr. 12542

ALLOYS . METALLURGY

12643 REGULARITIES IN THE SHORT-RANGE ORDER OF ALLOYS OF THE Cd–Mg SYSTEM.
.Kuz'menko and H.I.Kal'na.
rayin. fiz. Zh. (USSR), Vol. 3, No. 6, 841-4 (1958). In Ukrainian.

12644 PHASE TRANSFORMATIONS IN [CARBON] STEEL WITH ELECTROTEMPERING.
N.Hridnyev and V.I.Trefilov.
rayin. fiz. Zh. (USSR), Vol. 3, No. 6, 796-801 (1958).
Ukrainian.
The application of high heating rates induces considerable anges in the development of the tempering process. The first ect of tempering is displaced in the range of higher temperatures, d its temperature position does not depend upon the heating rate heating rates of 100° per sec and over. This effect is connected h the exit of carbon from the martensite lattice. The second ect of tempering is connected with the dissociation of the residual itenite. This effect is not revealed in the investigated interval of heating rate. But progressive dissociation of the residual itenite occurs as a result of a momentary holding before cooling, pecially in the middle temperature range. The third effect of npering is revealed fairly indistinctly even when the heating rate as high as 8000° per sec and is also displaced in the range of her temperatures as compared with ordinary tempering. Data re obtained on the change of the coercive force and hardness of ctrotempered steel.

12645 KINETICS OF PHASE TRANSITIONS IN ALLOYS OF THE Cd-Mg SYSTEM. P.P.Kuz'menko and H.I.Kal'na.
rayin. fiz. Zh. (USSR), Vol. 3, No. 6, 829-35 (1958).
Ukrainian.
The investigations were conducted on alloys with 20, 22, 25, 6, 33, 50, 66.7, 78, 80 atom per cent of Cd. The kinetic curves are well described by an exponential expression in the half-transition time $t_{1/2}$. A determination was made of the coefficient b in this expression, which proved close to unity. The dependence of $t_{1/2}$ on T^{-1} is virtually linear, which makes it possible to calculate the activation energy of the transition E_a. Data are presented on the dependence of E_a energy on the concentration. E_a proved to be proportional to the heat of transition Q, i.e. $E_a = kQ$, where k is a constant for all alloys and equals 90.

DAMPING OF ELASTIC VIBRATIONS IN TWO-PHASE MIXTURES. See Abstr. 11806

12646 PERIODIC ANTIPHASE STRUCTURES OR ALLOYS OF LONG PERIODS. P.Perio and M.Tournarie.
J. Phys. Radium (France), Vol. 21, No. 1, 71-3 (Jan., 1960).
In French.
Single crystal films of AuCu and AuMn, about 300 A thick and with a (100) orientation were studied using electron diffraction and microscopy. The results show that antiphase periodic structures are thermodynamically stable. Often the periods are not integral. The structures could be correlated with the electronic structure of the alloy in that the addition of an element of higher metallic valency reduced the period whereas a transition element of "negative" valency increased it. A.E.Kay

12647 THEORY OF ORDER OF MULTICOMPONENT NON-STOICHIOMETRIC SOLID SOLUTIONS (ZEROTH APPROXIMATION). K.F.Wojciechowski.
Physica (Netherlands), Vol. 27, No. 6, 509-13 (June, 1961).
Exact definitions of the superlattice and of sublattices of the multicomponent non-stoichiometric solid solutions are given. The number l of sublattices into which the superlattice can be subdivided is determined precisely, and the configurational free energy in the zeroth approximation, for arbitrary solutions is determined. All the conditions which the probabilities $p_{i\mu}$ of finding the atom of the i-th kind in the μ-th sublattice have to satisfy are also given.

12648 ACOUSTICAL STUDY OF QUENCH-AGING IN α Cu–Al ALLOYS. T.J.Koppenaal and M.E.Fine.
J. appl. Phys. (USA), Vol. 32, No. 9, 1781-2 (Sept., 1961).
Young's modulus at 21°C in quenched α Cu–Al alloys increases with time. This correlates with a decrease in resistivity which has been attributed to vacancy-enhanced diffusion and short-range ordering. The total change in modulus during ageing increases with Al content and quenching speed and is also a function of the quenching temperature. An effective activation energy of 0.69 eV was determined 38 min after quenching. This is an effective energy of motion for the point defects involved in the diffusion process at this point in the reaction.

12649 STUDIES OF AGEING AND PRECIPITATION IN METALS USING ANELASTIC DAMPING MEASUREMENTS. K.M.Entwistle.
Progress in non-destructive testing, Vol. 2 (see Abstr. 9239 of 1961) p. 189-222.
The nature and origin of the anelastic damping caused by stress-induced ordering of solute atoms is discussed, and measurements on ageing alloys which can be interpreted in terms of this effect are described. Important differences between the ordering process in interstitial and substitutional solid solutions arise from the need for vacant lattice sites in the migration of substitutional atoms, and the two types of solutions are discussed separately. J.B.Birks

12650 PRECIPITATION SITES IN ALUMINUM ALLOYS. G.R.Frank, Jr, D.L.Robinson and G.Thomas.
J. appl. Phys. (USA), Vol. 32, No. 9, 1763-4 (Sept., 1961).
Frank sessile dislocations surrounding a region of stacking fault are shown to be nucleation sites for γ' phase precipitation in aluminium-silver alloys. The segregation of silver to these regions is explained in terms of extinction fringe contrast. Direct evidence for "pipe" diffusion along dislocations to a grain boundary is also presented.

DISLOCATION DECORATION BY PRECIPITATION IN GOLD–COBALT ALLOYS. See Abstr. 12384

12651 GUIDED-STRING CUTTER FOR SINGLE, METAL CRYSTALS. A.R.Wayson.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 967-71 (Aug., 1961).
Describes a guided-string acid saw for the strain-free planar cutting of oriented single crystals. A Saran monofilament, used as the acid-carrying element, is guided completely through the cut by

a grooved blade serving the three-fold purpose of guide, pressure device, and follower for a position-sensing mechanism which automatically controls the feed. Guiding of the string results in a width-of-cut to string-diameter ratio considerably lower than that of unguided acid saws. Bismuth and copper crystals have been cut with excellent results using this device.

12652 PRECIPITATION AND IRRADIATION HARDENING IN IRON. D.Hull and I.L.Mogford.
Phil. Mag. (GB), Vol. 6, 535-46 (April, 1961).

Precipitation of carbon from α-iron during irradiation and thermal ageing were studied using thin-film electron transmission microscopy. During irradiation at 100°C precipitates formed with a density of 2×10^{24} cm^{-3} and saturated at 400 A diameter after 72 hours in a flux of

$$1.5 \times 10^{11} \text{ neutron cm}^{-2} \text{ sec}^{-1} > 1 \text{ MeV}.$$

The precipitates were in the form of plates parallel to {100} and occurred individually in the matrix and in rows on dislocation lines. Thermal ageing at 100°C produced clusters of plates with a density of 3×10^{13} cm^{-3} and rows of plates on dislocation lines. At higher ageing temperatures the plate-like precipitates were replaced by larger dendritic particles at 200°C and needle-shape particles at 250°C with a density of 3×10^{12} cm^{-3}. The defects produced during irradiation, which are responsible for irradiation hardening, were not detected. Tensile experiments showed that the hardening was most pronounced when precipitation did not occur.

12653 THE TEMPERATURE DEPENDENCE OF RESIDUAL ELECTRICAL RESISTANCE IN ORDERING ALLOYS.
N.V.Volkenshtein and É.V.Galoshina.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 494-5 (Sept., 1960). In Russian.

The resistances of Ni_3Mn and Cu_3Pd were measured at 77.8 and 293°K. The ratio of the resistances is shown as a function of the temperature at which the specimens were hardened.
R.F.S.Hearmon

12654 REFINING OF BERYLLIUM BY VACUUM DISTILLATION. V.E.Ivanov, V.M.Amonenko, G.F.Tikhinskii and A.A.Kruglykh.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 581-5 (Oct., 1960). In Russian.

Describes methods of metal refining by distillation in vacuum and deposition on hot surfaces. Shows how to remove impurities with vapour pressures similar to that of the metal being refined. Optimal conditions are reported for preparation of high-purity beryllium (99.987% without allowance for oxygen). Discusses reasons for the presence of carbon and oxygen impurities in beryllium refined by vacuum distillation. A.Tybulewicz

12655 THE MIGRATION OF SOLID METAL SOLUTION COMPONENTS IN A DIRECT-CURRRENT FIELD. I.
I.N.Frantsevych, D.F.Kalynovych, I.I.Kovens'kyi and V.V.Pen'kovs'kyi.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 124-34 (1958). In Ukrainian with Summary (1 p.) in Russian.

For evaluating the effect of impurities on the atomic bond strength in metal alloys (e.g. refractory alloys), the method of migration of the alloy components in a d.c. field may be the most effective. Such migration is a specific form of diffusion. The donor or acceptor ability of the alloy components may be determined by this method. In the present study, the method of radioactive tracers was first used for investigating metal migration in a d.c. field. The migration of both components in carbon steels, iron–chromium and iron–molybdenum alloys and the migration of tungsten in iron–tungsten alloys were investigated with the aid of the tracers C^{14}, Cr^{51}, Fe^{59}, Mo^{99} and W^{185}. Carbon, chromium and tungsten were found to migrate in a d.c. field towards the cathode, while molybdenum migrates towards the anode. Iron migrates towards the cathode in an iron–molybdenum alloy; in the other investigated alloys it migrates towards the anode. The results prove the donor ability of carbon and chromium and the acceptor ability of molybdenum in the studied alloys, iron being an acceptor in the first two cases and a donor in the last. The charge and the transfer ratios are calculated for the carbon ion in steel.

12656 THE MIGRATION OF SOLID METAL SOLUTION COMPONENTS IN A DIRECT-CURRENT FIELD. II.
I.N.Frantsevych, D.F.Kalynovych, I.I.Kovens'kyi and V.V.Pen'kovs'kyi.
Ukrayin. fiz. Zh. Dodatok. (USSR), Vol. 3, No. 2, 64-7 (1958). In Ukrainian.

A study was made of molybdenum migration in binary iron–molybdenum alloys using Mo^{99} as a tracer. Two alloys (contai 2 and 4.5% by weight of Mo) were investigated at temperature 950°, 1000°, 1050° and 1100°C and for different durations of the experiment. Molybdenum dissolved in iron was found to migra in a d.c. field towards the anode. The effect of the electrical migration increases with the length of exposure and with a ris temperature. The molybdenum migration velocities were calc for all the temperatures studied. The velocities were found to directly proportional to the molybdenum concentration in the s

12657 THE MIGRATION OF SOLID METAL SOLUTION COMPONENTS IN A DIRECT CURRENT FIELD. I
I.N.Frantsevych, D.F.Kalynovych, I.I.Kovens'kyi and V.V.Pen'kovs'kyi.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 552-9 (1958). In Ukra

An investigation was made (using Fe^{59} as a tracer) of the trical migration of iron in a solid solution of carbon in iron at temperatures of 900°, 950°, 1000°, 1050° and 1100°C. A specia procedure was worked out to eliminate distortion of the experi mental results caused by the strongly penetrating γ-radiation Fe^{59}. Iron atoms were shown to migrate towards the anode, acquiring a negative charge. The magnitudes of the charges ar migration numbers of iron atoms in austenite were calculated the basis of the experimental data. Calculation were also mad (at various temperatures) of the charges and migration number molybdenum atoms in two of its alloys with iron, with molybde concentrations of 2 and 4.5 weight%. It was established that th of iron atom migration in austenite, the charge and migration n decrease as the temperature rises above 900°C and equal zero 1100°C. The charge of molybdenum atoms in a solid solution w iron remains constant with a rise in temperature, while the migration number increases. The charge and migration numbe of molybdenum atoms increase with the rise of the molybdenum concentration in the alloy.

OTHER SOLID FORMS

ELECTRICAL CONDUCTIVITY OF GLASSES WITH TWO TYPES OF METAL IONS. See Abstr. 12420

12658 EFFECTS OF HIGH PRESSURE ON GLASS: A POSSIBLE PIEZOMETER FOR THE 100-KILOBAR REGION. R.Roy and H.M.Cohen.
Nature (GB), Vol. 190, 798-9 (May 28, 1961).

The density and refractive index of silica glass were meas as a function of pressure up to 160 kbar. Much greater change were found than were reported by Bridgman and Simon (Abstr. of 1953). If the new results can be confirmed, it is proposed th the refractive index of silica would be a useful piezometer.
D.M.Sch

12659 INVESTIGATION OF THE AGEING PROCESS IN TITANIUM-CONTAINING CERAMICS BY MEANS O ELECTRON PARAMAGNETIC RESONANCE.
V.V.Antuf'ev, M.P.Votinov, E.V.Kuvshinskii and A.G.Savin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 286-8 (Jan., 1961). In Russian.

Electron paramagnetic resonance measurements on an electrically aged titanate ceramic at 77°K showed increases in concentration of paramagnetic defects with $g \cong 1.93$ and 1.97 as compared with the initial ceramic. Chemical reduction of the initial ceramic in an atmosphere of CO at 900°C led only to an increase in the concentration of paramagnetic defects with $g \cong 1$ [English translation in: Soviet Physics — Solid State (USA), Vo No. 1, 208-9 (July, 1961)]. R.F.S.Hea

12660 PRECISION METHOD FOR DETERMINATION OF P STRUCTURE BY PHOTOGRAPHIC PHOTOMETRY.
J.Cohen and A.Sandor.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1023-8 (Sept., 1961).

A method for the precise determination of pore structure u photographic photometry is described. Porosity, homogeneity, average pore size, and separation are determinable. Special metallographic and photographic techniques are used to obtain nearly exact photomicrographic replica of the test sample, and porosity is measured with an integrating reflectometer. Desig construction details of this instrument are given. The method

ed to the matrix evaluation of porous tungsten. Advantages of ethod are low cost, simplicity, rapidity, elimination of in errors and tediousness, high resolution, and great accuracy.

rfaces . Films . Adsorption

THE INFLUENCE OF A GASEOUS DISCHARGE ON THE TACT POTENTIAL OF METAL SURFACES. See Abstr. 12372

12661 THE STRUCTURE OF A SCALE ON TITANIUM.
D.I.Lainer and M.I.Tsypin.
Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 543-54 ., 1960). In Russian.
Sheets of vacuum-annealed titanium were oxidized at -850°C for 3 hr in air or in water vapour. X-ray diffraction, tron diffraction and microscopic studies gave the crystal struc-, phase composition and texture of the scale which consisted i oxides. A.Tybulewicz

12662 ELECTRON DIFFRACTION INVESTIGATION OF THE STRUCTURE OF THIN FILMS OF INDIUM SELENIDE
In_2Se_3. S.A.Semiletov.
. tverdogo Tela (USSR), Vol. 3, No. 3, 746-53 (March, 1961). Russian.
The existence of at least 4 phases in In_2Se_3 is established. o of the phases, α and β, are hexagonal, one is cubic and one noclinic. The α-phase is stable at room temperature; the hase is stable above 200°C. The structure of the α- and β- ses is determined and discussed in some detail. A possible mic transition is suggested to account for the large fall in ctrical conductivity accompanying the α-β transformation. glish translation in: Soviet Physics — Solid State (USA), Vol. 3, 3, 544-8 (Sept., 1961)]. R.F.S.Hearmon

12663 CHARACTERISTICS OF THE ANNEALING KINETICS OF TIN FILMS DEPOSITED AT 88°K.
riest, C.Chiou and H.L.Caswell.
appl. Phys. (USA), Vol. 32, No. 9, 1772-6 (Sept., 1961).
The electrical resistance of evaporated, high purity tin films osited at 88°K decreases rapidly in two temperature regions as ermined by isothermal annealing studies. One pronounced aling peak occurs at 110°K and has an activation energy of .4 ± 0.06 eV. The second much less pronounced peak at 180°K s an activation energy of 0.74 ± 0.10 eV. The annealing aracteristics of five pure films varying in thickness from 960 to 00 A and a film deposited in a high partial pressure of N_2 are ite reproducible. The presence of O_2 during evaporation, however, astically altered the annealing kinetics and increased the activation ergy at any given temperature. The defect resistivity at the time evaporation was the same for all five pure films and a film posited in a high partial pressure of N_2, but is about 75% higher r the film deposited in the presence of O_2.

12664 THE PREPARATION OF CONTINUOUS SINGLE-CRYSTAL THIN FILMS OF NICKEL AND NICKEL—IRON ALLOYS.
S.Heavens, R.F.Miller, G.L.Moss and J.C.Anderson.
oc. Phys. Soc. (GB), Vol. 78, Pt 1, 33-6 (July, 1961).
Thin films of nickel and some face-centred cubic nickel—iron oys were grown epitaxially from the vapour phase on to the incipal planes of rock salt and copper, and their structure and lentation investigated by transmission electron microscopy. nditions were determined for the production of continuous films thickness down to 100 A. The mass and composition were deter-ned microchemically; thicknesses given are on the assumption of lk density.

12665 METHOD FOR EVAPORATION IN VACUUM OF SUBLIMABLE MATERIALS. F.E.Card and J.J.Galen.
v. sci. Instrum. (USA), Vol. 32, No. 7, 858-9 (July, 1961).
A quartz annular crucible with internal and external heaters rmits very slow vacuum evaporation of sublimable materials en they are mixed with alumina crystals. Crystalline films of S were deposited in this way at a rate of 0.2 μ/hr up to several crons thick. W.J.Hammond

12666 PHYSICAL ADSORPTION OF NITROGEN ON PYREX AT VERY LOW PRESSURES. J.P.Hobson.
chem. Phys. (USA), Vol. 34, No. 5, 1850-1 (May, 1961).
Measurements of the adsorption isotherms of N_2 on Pyrex (Corning 7740) over ranges of temperature, pressure, and surface coverage of 63.3°-90.2°K, 5×10^{-10}-10^{-3} mm Hg, and $10^{-4} \leq \theta \leq 0.3$, respectively, lead to the following conclusions: (1) the adsorbing surface is non-porous and (from examination with an electron microscope) nearly flat; (2) the Dubinin—Radushkevich adsorption isotherm equation to which the results conform and which might not be expected to apply to physical adsorption at very low coverage (as in the present instance) can only be considered a useful empirical relation. W.Good

12667 ADSORPTION OF BARIUM ATOMS AND BARIUM OXIDE MOLECULES ON TUNGSTEN. I.
Yu.S.Vedula and V.M.Havrylyuk.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 632-50 (1958). In Ukrainian, with summary (4 pp.) in Russian.
The following were shown experimentally: (a) The heats of adsorption q_0 of Ba and BaO on the atom-pure surface of a tungsten ribbon subjected to high-temperature hardening in vacuum are respectively equal to 4.8 and 5.08-5.15 eV; for Cs—W, q_0 is equal to 3.1 eV (calculated from the data of Taylor and Langmuir). (b) The heats of adsorption $q(\Theta)$ for the systems Ba—W, BaO—W and Cs—W are practically not linearly dependent on the degree of coating, decreasing with its growth. The values $\delta q(\Theta) = q_0 - q(\Theta)$ proved to be, within the limits of experimental error, the same for all three systems at $\Theta < 0.5$ and are well described by the given empirical formula throughout the interval of Θ variation. (c) The equation for $(-d\Theta/dt)$ from the theory of absolute reaction velocities, together with the empirical expression, satisfactorily describe the adsorption of Ba, BaO and Cs on W and permit the calculation of the isobars, isotherms and other characteristics of adsorption and desorption.

12668 ADSORPTION OF BARIUM ATOMS AND BARIUM OXIDE MOLECULES ON TUNGSTEN. II. V.M.Havrylyuk.
Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 734-49 (1959). In Ukrainian.
For Pt I, see preceding abstract. A theory of the interaction of atoms adsorbed on a metal surface is outlined. It is based on the assumption of the electrostatic nature of this interaction. The calculations are carried out for three models: Langmuir's (polarized atom on metal surface), De Boer's (polarized ion on metal surface, forming together with its mirror image a hard dipole) and the general model proposed by the author (polarized ion, forming together with its mirror image a soft dipole), which embraces both the preceding ones. Formulae are derived for calculating the change in the work function with the degree of covering $\Delta\varphi(\Theta)$ and the change in the heat of adsorption $\delta q(\Theta)$. The author proposes a criterion and formula for the determination of the number of adatoms in the monolayer n_1 per cm^2 of surface. A calculation is also made of the interaction of adatoms, approaching to a distance less than the constant lattice of the monolayer, which explains both quantitatively and qualitatively the course of $\delta q(\Theta)$ with $\Theta > 0.5$. A comparison of theory and experiment is made for the system Ba—W and Cs—W. The author's model proved to be the only one to yield good agreement. Agreement was worse for De Boer's model and Langmuir's model is altogether unsuitable for describing Ba and Cs adsorption on W. It was for this last model that calculation of $\delta q(\Theta)$ was carried out earlier [see, for example, Abstr. 1621 of 1927; 4748 of 1935. The adsorption of gases on solids, Cambridge: University Press (1949)], and on this basis the inference generally accepted in the literature was drawn, i.e. that the electrostatic interaction of adatoms on the surface may account for the experimentally found values for the change in the heat of adsorption with change in Θ. Consequently, this inference is connected with an improperly chosen model of the phenomenon. With proper selection of the model, the inference becomes unsound. The good agreement of $\Delta\varphi(\Theta)$, $\delta q(\Theta)$ and the n_1 data for the Ba—W and Cs—W systems obtained from the theory with the experimental measurements shows that the electrostatic interaction of adsorbed atoms is very substantial. It is evidently of decisive importance for the phenomena under consideration.

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

12669 MOSAIC SIZE IN LEAD FROM X-RAY MEASUREMENTS. Y.Hiki and R.R.Hasiguti.
J. appl. Phys. (USA), Vol. 32, No. 9, 1647-50 (Sept., 1961).

The size of mosaic blocks in lead powder was determined on the basis of the primary extinction effect of X-rays. Integrated intensities of nine reflection lines in the Debye–Scherrer spectrum with Cu K_α radiation were measured with a Geiger counter spectrometer. The mosaic size was calculated by comparing these values with theoretical values of the intensities. Correction for absorption of X-rays in the specimen powder was especially important because of the large absorption coefficient of lead. The order of magnitude of the mosaic size was found to be 10^{-4} cm. From this value, the dislocation density was calculated to be of the order of 10^8 cm^{-2}. The dislocation density decreased slightly when the specimen was annealed in vacuo at 150°C for a long time.

12670 DIFFUSE SCATTERING OF X-RAYS BY GAMMA-RAY IRRADIATED ROCHELLE SALT.
K.Toyoda, A.Shimada and T.Tanaka.
J. Phys. Soc. Japan, Vol. 15, No. 3, 536-7 (March, 1960).

Changes in the ferroelectric and piezoelectric properties of Rochelle salt crystals take place when the crystals are exposed to γ-rays. Changes also occur in the X-ray diffraction patterns and these were studied by taking Laué photographs with crystal slices 0.7 mm thick. With doses of up to 10^8 r there is no appreciable change in the diffraction pattern although the ferroelectric properties change. Larger doses cause diffuse spots, which are associated with Laué spots, to appear and increase in intensity but with much higher doses the Laué spots split and the intens of the diffuse spots decreases. No streaks or fine structure a observed in the diffuse spots. J

12671 AUTOMATIC SHADOWING DEVICE FOR ELECTR MICROSCOPY. F.W.Bishop and S.Bogitch.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 603-5 (May, 1961).

Detectors, in the form of old filament mounts with the fila wires cut off, are fixed in the bell jar of the evaporator near t specimen to be coated. The resistance between the legs of a m falls as the evaporated material is deposited and when it reach a predetermined value the current passed actuates a cut-out in lead to the filament from which the evaporation is occurring. evaporation proceeds until a given thickness of film has been deposited. The method may be used in the evaporation of carb well as metals. A photograph of the apparatus and a schematic wiring diagram of the circuitry of the automatic shadow-caster reproduced. V.E.Cos

12672 SAMPLE PREPARATION FOR TRANSMISSION ELECTRON MICROSCOPY OF GERMANIUM.
R.P.Riesz and C.G.Bjorling.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 889-91 (Aug., 1961).

Bulk samples of germanium were reduced to sections thin enough for transmission electron microscopy. The apparatus techniques of this virtual-electrode electrolytic etching proces are described in detail with emphasis on the geometric control obtained. An example is given of an electron transmission mic graph of a section 500 A thick.

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

12673 EFFECT OF RELAXATION OF CHEMICAL ENERGY ON THE THERMAL CONDUCTIVITY OF THE SYSTEM $N_2O_4 \rightleftharpoons 2NO_2$. B.N.Srivastava and A.K.Barua.
J. chem. Phys. (USA), Vol. 35, No. 2, 649-51 (Aug., 1961).

Franck and Spalthoff's treatment is applied to interpret the authors' thermal conductivity data for the system $N_2O_4 \rightleftharpoons 2NO_2$ (see Abstr. 10549 of 1961). The results are satisfactory in view of the several simplifying assumptions in the treatment, when the chemical accommodation coefficient is also considered. It is seen that the none too satisfactory results obtained previously by Coffin when applying Franck and Spalthoff's treatment to this system are mainly due to the neglect of the chemical accommodation coefficient.

12674 DECOMPOSITION OF DIMETHYL CARBONATE ON QUARTZ. M.H.J.Wijnen.
J. chem. Phys. (USA), Vol. 34, No. 4, 1465-6 (April, 1961).

The thermal decomposition of dimethyl carbonate over the temperature range 147-257° C within a quartz reaction vessel was studied. Main reaction products are dimethyl ether and CO_2.
G.I.W.Llewelyn

12675 COLLISION AND ACTIVATED COMPLEX THEORIES FOR BIMOLECULAR REACTIONS. K.Yang and T.Ree.
J. chem. Phys, (USA), Vol. 35, No. 2, 588-92 (Aug., 1961).

By using the principles of classical mechanics, the specific rates k' of bimolecular reactions which proceed without activation energies were obtained by taking the average of $\pi b_c^2 g$, where b_c is the critical impact parameter and g is the relative molecular velocity. The result is

$$k' = (\beta/\sqrt{\mu})(kT)^{(s-4)/2s} C^{2/s}.$$

Here, C and s are the constants appearing in the attractive potential, $C/r^s (s > 2)$, between two reacting molecules separated by a distance r, β is a dimensionless quantity involving s, μ is the reduced mass, and other symbols have their usual meaning. After substituting proper potential parameters into the above equation, the authors obtained the rates of the reactions for the systems, ion–molecule and radical–radical, in exact agreement with the rates in the literature obtained using the activated complex theory. The reason for the agreement was considered, and it was shown tha under two conditions pointed out in the text the equations of k' obtained from the activated complex theory transform to those derived from the classical collision theory.

12676 FLAT FLAME BURNER FOR BURNING UNDILUTE PREMIXED HYDROGEN AND FLUORINE. S.Kaye.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 965-6 (Aug., 1961).

A burner capable of burning hydrogen and fluorine as prem reactants at low pressures is described. The construction of t burner was such that the reaction, which is normally considere spontaneous when the gases come in constact, remained suppre until the lip of the burner was reached. Combustion occurred c an extremely wide range of fuel–oxidant ratios including mixtu rich in fluorine. The flame produced by the burner was flat an symmetrical in shape.

12677 GASEOUS DETONATIONS. XIV. THE CH RADICA ACETYLENE OXYGEN DETONATIONS.
R.K.Lyon and P.H.Kydd.
J. chem. Phys. (USA), Vol. 34, No. 3, 1069-70 (March, 1961).

In Pt. XII, see Abstr. 5629 of 1959. The time-resolved ab sorption spectrum of a detonation was studied in an equimolar mixture of acetylene and oxygen at an initial pressure of 6 mm The 3143 A band of CH appears directly behind the shock front, the OH absorption appears and the CH absorption disappears. readily concluded from a consideration of detonation wave velo temperature, and the reaction equilibrium $C_2H_2 \rightleftharpoons 2CH$ that CH not formed by acetylene dissociation but by some oxidation rea W

ELECTROCHEMISTRY

12678 THEORY OF ELECTROCHEMICAL DIODES.
I.Oshida.
hys. Soc. Japan, Vol. 15, No. 12, 2288-94 (Dec., 1960).
The electric behaviour of electrochemical diodes, consisting pair of neutral electrodes immersed in an electrolytic tion being capable of reversible oxidation–reduction, is stigated theoretically. The general current–voltage relation is ined by solving the differential equation of diffusion of ions with proper boundary conditions. The non-ohmic property, the ıting effect for rapidly changing voltage and the rectifying action deduced.

12679 RESONANCE PHENOMENA OBSERVED AT LOW FREQUENCIES DURING ELECTROLYSES ACCOMPANIED STRONG ANODIC OVERVOLTAGE. I.Epelboin and G.Loric.
Phys. Radium (France), Vol. 21, No. 1, 74-6 (Jan., 1960).
French.
A study of the strong anodic overvoltages which appear during ctrolytic polishing and anodic oxidation is reported. The data 'eal resonance phenomena for which an interpretation is sub- tted. H.H.Hodgson

THE INFLUENCE OF A MAGNETIC FIELD ON THE MOTION OF RTICLES IN SOLUTIONS OF ELECTROLYTES.
Abstr. 11905

PHOTOCHEMISTRY RADIATION CHEMISTRY

12680 INFRARED SPECTROSCOPIC STUDY OF THE PHOTOLYSIS OF CHLORINE AZIDE IN SOLID ARGON AT 20°K. D.E.Milligan.
chem. Phys. (USA), Vol. 35, No. 1, 372-3 (July, 1961).
The infrared bands obtained on irradiation of ClN_3 using a ercury lamp are interpreted. Bands observed at 818 and 824 cm^{-1} e assigned to $N^{14}Cl^{35}$ and $N^{14}Cl^{37}$, respectively. G.I.W.Llewelyn

12681 MOLECULAR DETACHMENT PROCESSES IN THE VACUUM U.V. PHOTOLYSIS OF GASEOUS HYDROARBONS. I. ETHYLENE. II. BUTANE.
.C.Sauer, Jr and L.M.Dorfman.
chem. Phys. (USA), Vol. 35, No. 2, 497-502 (Aug., 1961).
The photolysis of ethylene and of butane was studied at room mperature with light of 1470 A. The results of isotopic studies, ong with a detailed examination of the products of reaction, tablish conclusively that molecular detachment processes are of ajor importance in the primary decomposition of the photoexcited ates formed. In the photolysis of ethylene at 1470 A the primary ocesses are

$$C_2H_4^* = C_2H_2 + H_2 \qquad \phi_1$$

$$C_2H_4^{**} = C_2H_2 + 2H \qquad \phi_2$$

with $\phi_1 \cong \phi_2$. Rupture of only a single carbon–hydrogen bond is not an important primary process. The foregoing reactions, along with the subsequent interactions of ethyl radicals, formed by hydrogen atom addition to ethylene, furnish a unique description of almost all the photochemistry observed under the conditions of the experiments. In the photolysis of butane at 1470 A, molecular detachment of hydrogen:

$$C_4H_{10}^* = C_4H_8 + H_2$$

is a major primary process. The detailed nature of any other primary reactions has not been established.

PHYSICAL METHODS OF CHEMICAL ANALYSIS

12682 THE ANALYSIS OF MICRO-IMPURITIES WITH A MAGNETIC-RESONANCE MASS SPECTROMETER. II. CALCULATION OF THE NOISE CURRENT. G.E.Pikus and V.B.Fiks.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3120-8 (Dec., 1960).
In Russian.
In Pt I (see Abstr. 14157 of 1960) the authors showed that the resonance-type mass spectrometer was capable of analysis at high resolution. The present paper is concerned with the calculation of the general noise background which arises chiefly from gas scattering effects. Detailed expressions are derived. [English translation in: Soviet Physics – Solid State (USA), Vol. 2, No. 12, 2774-84 (June, 1961)]. A.E.I. Research Laboratory

12683 CONCENTRIC BIPOLAR OXYGEN SENSITIVE MICROELECTRODE. E.A.Rice.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 892-3 (Aug., 1961).
The construction of a bipolar oxygen-sensitive polarographic microelectrode is described. A platinum wire serves as the active electrode and the reference electrode is a gold plate on an indium–tin base. The electrode has an outside diameter of approximately 70 μ. It is sturdy, electrically stable, highly sensitive to changes in oxygen concentration, and is nontoxic to animal tissue.

12684 ELECTRONEGATIVE GAS DETECTOR.
R.E.Fox, P.R.Malmberg and R.B.Gosser.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 898-901 (Aug., 1961).
An electronegative gas detector has been developed which is capable of measuring one part of SF_6 in 10^7 parts of air. The operation of the instrument is based on the differences between various electronegative gases in the rates of electron attachment at low electron energies, and on the differences of mobilities of the resulting negative ions in an electric field. The instrument operates at atmospheric pressure ($E/p \sim 1$ V/cm mm Hg) and uses a modulated ultraviolet light source to produce at a photocathode pulses of photoelectrons which are attached to produce negative ions. The differences in cathode–anode transit times of the negative ions result in different phase shifts of the observed cathode current. The measured phase shifts serve to indicate the amount of electronegative gas present.

GEOPHYSICS

12685 SOUND-SPEED MEASUREMENTS UTILIZING THE BATHYSCAPH TRIESTE. K.V.Mackenzie.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1113-19 (Aug. 1961).

Sound-speed measurements and corresponding oceanographic data were obtained aboard the bathyscaph Trieste to a depth of 5760 m. Subsequent measurements were made in shallow northern waters by lowering the velocimeters and Nansen bottles from a surface ship. Near-surface measurements agree with the laboratory data of either Del Grosso (1952) or Wilson (Abstr. 10721, 19276 of 1960). One set of the deeper measurements aboard the bathyscaph indicates a general agreement with Wilson, but the measured values were less than values computed by Wilson's equations and this difference increased with depth. The acceleration of gravity was measured at a depth of 2286 m and the increase with depth was in rough agreement with the equation in H.V. Sverdrup's The Oceans. Englewood Cliffs, N.J.: Prentice Hall (1949)].

12686 INTERNAL WAVES IN THE OCEAN. C.Eckart.
Phys. of Fluids (USA), Vol. 4, No. 7, 791-9 (July, 1961).

Salinity, temperature, and pressure gradients all cause the density of sea water to vary with depth in the ocean, and the density gradient affects the motion of the waters. A quantity N, having the units radians per second, can be defined using the density gradient, the velocity of sound, and the acceleration of gravity. The simplest motions have the form of horizontally progressive waves of frequency ω, wave number κ, and velocity V. If h is the amplitude of the vertical displacement of the water and z the vertical coordinate, then $V^2(d^2h/dz^2) + [N^2(z) - \omega^2]h = 0$; this equation is formally identical with Schrödinger's wave equation. The stream function of these waves is $\varphi = Vh(z)\ \sin(x - \omega t)$, and the variable part of the pressure is $-\rho\, d\phi/dz$, while the vorticity is $R = -N^2\varphi/V^2$. The wave may be described as a lattice of vortices moving with velocity V. In the ocean, N(z) ordinarily has one or two maxima, called thermoclines. The analogy with the quantum-mechanical problems of one and two potential minima is exploited to obtain semiquantitative solutions for the internal waves associated to thermoclines.

SOUND PROPAGATION IN SHALLOW WATER.
See Abstr. 11811

SOUND REFRACTION IN SEAS See Abstr. 11814

ATMOSPHERE

(Troposphere and Stratosphere)

12687 ELECTRONIC DISDROMETER. D.E.Clardy and C.W.Tolbert.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 916-19 (Aug., 1961).

Describes an instrument for the rapid and continuous measurement of raindrop-size distributions. A slit of light is used as the sensing element of this disdrometer. Electronic circuits analyse information from a phototube and record the number of drops, within certain size ranges, as they fall through the light slit. The disdrometers of other investigators are reviewed, the characteristics of raindrops are listed, and a raindrop-size distribution recorded by the light slit-phototube disdrometer is presented. The recorded drop-size distribution agrees well with the distribution postulated by Laws and Parsons (1943).

12688 THE PRODUCTION RATE OF NATURAL TRITIUM. H.Craig and D.Lal.
Tellus (Sweden), Vol. 13, No. 1, 85-105 (Feb., 1961).

A detailed evaluation is made of the production rate of natural tritium in the pre-thermonuclear epoch. Deuterium and tritium analyses on the same precipitation samples are used to establish the uncontaminated tritium levels in precipitation sampled before the Castle tests, and the tritium balance is calculated for the North American troposphere. The global mean production rate Q, calculated from the geochemical inventory, is found to be 0.5 ± 0 atoms T/cm² sec. This value is three to four times smaller th values found previously by such calculations because of the follo developments: (1) The deuterium and tritium data show that th increases in tritium content observed during early thermonucl tests before Castle are due to addition of synthetic tritium rath than to random fluctuations. The deuterium–tritium relationsh are used to establish the general pattern of tritium variations the North American continent and to evaluate the uncontaminat tritium levels. (2) The mean stratospheric residence time for tritium is found to be about 1.6 years from studies on fission product fallout and from the latitudinal variation of stratospher cosmic ray production. (3) Stratospheric tritium is preferentia injected into the troposphere at high latitudes, as shown by falli observations. The tritium influx into the North American tropo sphere is therefore higher than the mean global value. The predicted production rate is calculated from cosmic ray and nuclear cross-section data using the star production rates in th atmosphere. The predicted mean global tritium production rat during an average solar cycle is found to be 0.25 ± 0.08 atoms T/cm² sec. The variation in the production rate over an averag solar cycle is found to be ±4.5%. Within the uncertainties of th data and calculation, the production rates calculated from the geochemical inventory and from the cosmic ray data are in agr ment, and there is thus no observational evidence for accretion tritium from an extra-terrestrial source.

12689 IONIZATION EQUILIBRIUM IN MARITIME AIR. T.C.O'Connor and W.P.Sharkey.
Proc. Roy. Irish Acad. A, Vol. 61, No. 3, 15-27 (Nov., 1960).

By measuring the total number Z and the number No of un charged nuclei per cm³ in the air on the west coast of Ireland, a by deducing the mean size of the nuclei from measurements of diffusion coefficients, the authors have studied the variation of ratio Z/N_O with radius. Using data from two different methods determining these quantities, they find that the results agree we with Boltzmann's law applied to the charge distribution on the p icles of a monodisperse aerosol decreasing concentration of cha being associated with increase in size of nuclei. In can therefo be inferred that equilibrium conditions exist in the westerly air stream from the ocean, except for occasions of marked hetero- geneity which are attributable to natural sources along the shor distant artificial origins in America or even Europe. J.M.

12690 CALCULATIONS OF TURBULENT EXCHANGE COEFFICIENTS IN AIR AT WAGENINGEN. W.J.Derksen and W.R.Gardner.
Physica (Netherlands), Vol. 26, No. 11, 1012-13 (Nov., 1960).

In cases of a sudden variation in the incoming solar radiati the turbulent exchange coefficient can be calculated from the temperature variation at two different heights. Assuming a lin variation with height of the turbulent diffusivity given by $\lambda = b(z$ the calculation is made by using the Laplace transform of temp ture at the two heights according to the method of Van Wijk, Derksen and Goedkoop. Continuous temperature observations a 200 and 10 cm above a field of short grass over the period 1954 were used and the results for a number of typical situations we tabulated. No relationship was found between the values of b ar wind velocity or Richardson-numbers. R.S.

12691 ON GENERATION AND FRICTIONAL DISSIPATION KINETIC ENERGY IN THE ATMOSPHERE. E.Palmén.
Comment, phys-math. (Finland), Vol. 24, No. 11, 15 pp. (1960).

Taking the mean value of the drag coefficient of the atmosp as 2.0×10^{-3} over the oceans and 3.5×10^{-3} over the continents the rate of frictional dissipation if kinetic energy over the whol the northern hemisphere north of 30°N is computed to be 54×1 kW for a representative winter day. The rate of dissipation of energy within the atmosphere cannot be readily assessed becau little is known of the variation of the coefficient of eddy viscosit with height, but it is probably only about 5×10^{10} kW in the tropo sphere over the same area. The combined dissipation of kinetic energy is made good by conversion of potential into kinetic ener and this is estimated to take place at a rate of 28×10^{10} kW ove same part of the northern hemisphere. The reasons for the dis crepancy are discussed. J.M.

WHISTLER MECHANISM. See Abstr. 11925

SCATTERING OF ELECTROMAGNETIC WAVES IN THE POSPHERE. See Abstr. 12021

692 THE PRESENCE OF LONG LIFE ALPHA EMITTERS IN THE AIR. R.D.Lonati.
ia nucleare (Italy), Vol. 8, No. 3, 217-20 (March, 1961).
he energy spectrum of the long-lived α-activity in the air les collected on the filter papers during different periods was ied with ionization chamber. The measurements show that of the emitted α-particles have energies around 5 MeV and he activity increases with time. These facts seem to indicate resence of Po^{210} (RaF) in the atmospheric dust examined.
J.B.Garg

UPPER ATMOSPHERE IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

.2693 THE ELECTRICALLY SHORT ANTENNA AS A PROBE FOR MEASURING FREE ELECTRON DENSITIES AND LISION FREQUENCIES IN AN IONIZED REGION.
ng, C.W.Harrison, Jr and D.H.Denton, Jr.
es. Nat. Bur. Stand. (USA), Vol. 65D, No. 4, 371-84 (July-Aug.,).
If the admittance of a missile, satellite, or drone-aircraft al is monitored as the vehicle traverses an ionized region, it is ible to determine the free electron density and the collision uency of the region if theoretical relations between these tities are available. In this paper formulae are developed that te the admittance of an electrically short centre-driven dipole base-driven monopole when immersed in a conducting dielec- to the effective dielectric constant and conductivity of the ium. From well-known formulae relating these quantities to free electron density and the collision frequency of an ionized on, these latter may be determined directly from measured ittances. The results obtained when the aerial is treated as mped capacitor are considered. It is shown that when the uctivity of the medium is increased to a value that is still quite all, the effect of radiation on the input admittance becomes ligible. The electrically short aerial immersed in sea water is ussed briefly.

12694 PROPAGATION AND GENERATION OF LOW-FREQUENCY ELECTROMAGNETIC WAVES IN THE PER ATMOSPHERE. B.N.Gershman and V.A.Ugarov.
ekhi fiz. Nauk (USSR), Vol. 72, No. 2, 235-71 (Oct., 1960).
ussian.
A general review article summarizing both experimental and oretical knowledge on whistlers and v.l.f. emissions. The use of -frequency radio waves to provide information on the upper osphere (such as electron concentration, magnetic field, velocity olar corpuscular streams, etc.) is also discussed, and the review s with a consideration of some unsolved problems. [English nslation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 5, 743-64 rch-April, 1961)].
G.M.Brown

12695 ON THE VALIDITY OF SOME APPROXIMATIONS TO THE APPLETON-HARTREE FORMULA.
avies and G.A.M.King.
es. Nat. Bur. Stand. (USA), Vol. 65D, No. 4, 323-32 (July-Aug., 1).
The validity of some commonly used quasi-transverse and si-longitudinal approximations to the Appleton magneto-ionic mula is considered. Using the dipole approximation for the th's magnetic field the various approximations for the refractive ex are compared with the values computed from the complete mula for various geomagnetic latitudes and a frequency of 2.0 /s. It is found that certain approximations become very poor y a short distance from where they are exact and so care must aken in their use. It is shown that a choice of two suitable approxmations yields refractive indices of sufficient accuracy for all geomagnetic latitudes. Certain approximations to the group refractive indices are also considered.

12696 DIURNAL VARIATION OF THE PATH LENGTH OF 10 km WAVES. B.Decaux and A.Gabry.
C.R. Acad. Sci. (France), Vol. 252, No. 15, 2187-9 (April 10, 1961).
In French.
The continuous recording of the phase of the standard frequency transmissions from Rugby (GBR) and Panama (NBA) shows a variation between night and day, dependent on distance. Variations at sunset and sunrise have a characteristic rate; several recent geophysical phenomena have produced remarkable perturbations.
D.Walsh

12697 VARIATION IN HEIGHT OF ANISOTROPY AND RANDOM DRIFT VELOCITY OF THE IRREGULARITIES IN THE IONOSPHERE. B.Ramachandra Rao and K.V.V.Ramana.
Nature (GB), Vol. 190, 706-7 (May 20, 1961).
Horizontal drifts of ionospheric irregularities, at heights between 100 and 400 km, were studied in South India by the spaced receiver method, using pulses at several radio frequencies. The elongation of the irregularities, and the rate of random change of the fading pattern, were found to be much greater at 270 to 290 km than at other heights.
H.Rishbeth

12698 MOLECULAR IONS IN THE UPPER ATMOSPHERE. A.D.Danilov.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 5, 1098-1101 (April 11, 1961).
In Russian.
The paper discusses rocket and satellite data about the positive-ion composition of the E and F layers. The reactions which are commonly supposed to control the formation and removal of O^+, NO^+, O_2^+, N^+ and N_2^+ ions are reviewed. A mechanism involving the direct association of oxygen atoms and O^+ ions is postulated to account for the distribution of O_2^+ ions.
H.Rishbeth

12699 NITROGEN IONS IN THE UPPER ATMOSPHERE OF THE EARTH AND THE NOCTURNAL IONIZATION OF THE E REGION. V.G.Istomin.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 5, 1102-5 (April 11, 1961).
In Russian.
Data on the height distributions of N^+ and N_2^+ ions, between 100 and 500 km altitude, are summarized: Russian results obtained by mass spectroscopy (in situ) are compared with American optical data. Details of mass spectrograms obtained between 100 and 125 km, during two rocket flights, are also shown. In addition to the NO^+ and O_2^+ ions which predominate at these levels, there are also N_2^+, Mg^+, Ca^+, and Fe^+ ions. It is suggested that the metallic ions are of meteoric origin, and that meteors are responsible for ionization of atmospheric N_2.
H.Rishbeth

12700 VARIATIONS IN THE INTENSITY OF THE 6562 A H I LINE IN THE SPECTRUM OF THE NIGHTGLOW OF THE SKY. L.M.Fishkova and G.V.Markova.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 4, 799-801 (Oct. 1, 1960).
In Russian.
Spectrographic and photometric observations were made between January 1858 and September 1959 on the H_α (6562 A), O I (6300 A, 5577 A) NaII (5890 A), OH (9—3 and 6—1) spectral features of the airglow at the Abastuman astrophysical observatory. The annual variation in intensity in all the features except H_α followed the expected fashion. H_α showed a marked maximum intensity in July of each year. This was explained by resonance scattering of solar radiation in the Lyman series by interplanetary hydrogen. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 5, 1042-4 (March-April, 1961)].
R.W.Nicholls

12701 FLUX AND ENERGY SPECTRA OF THE PROTONS IN THE INNER VAN ALLEN BELT.
J.E.Naugle and D.A.Kniffen.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 3-6 (July 1, 1961).
Measurements were made on eight emulsions, each exposed for approximately 80 sec at different times during a missile flight with apogee near 1900 km. The three highest altitude exposures were analysed for proton energies up to 100 MeV. At the higher latitudes the slope of the spectrum below 40 MeV is very steep compared to predictions from galactic cosmic-ray albedo theory.

Possible mechanisms are discussed. At a comparable position in the belt the flux and shape of the spectrum agree with previous data. M.R.C.McDowell

GEOMAGNETISM

12702 THE MAGNETIC PROPERTIES OF THREE CARBONIFEROUS SILLS. C.W.F.Everitt.
Phil. Mag. (GB), Vol. 6, 689-99 (May, 1961).

An account is given of palaeomagnetic measurements on borehole specimens from three dolerite sills of Carboniferous age. The magnetic directions were closely grouped for one sill but widely scattered for the other two, showing that contrary to the experi of previous workers, specimens from underground do not alway yield satisfactory palaeomagnetic results. The intensities of magnetization were very low at the margin of each sill. In one instance this phenomenon was studied in detail. It seems to be to the fact that at the margins, the iron occurred mainly in the of the nonmagnetic carbonate, produced when the sill was intru into limestones. Some wider implications of the work are discu

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

12703 NEGATIVE ENTROPY AND PHOTOSYNTHESIS. W.Brittin and G.Gamow.
Proc. Nat. Acad. Sci. USA, Vol. 47, No. 5, 724-7 (May, 1961).

Comparison of the entropy increase, in the irreversible transformation of high-frequency quanta in solar radiation into low-frequency quanta (required for equilibrium at earth temperature), with the entropy decrease in the photo-synthesis occurring in plant leaves, shows that the growing of a plant in sunlight is consistent with the second law of thermodynamics. J.Hawgood

12704 DEVICE FOR INDIRECT REGISTRATION OF THE CALIBRATED ARTERIAL UPSTROKE IN MAN. S.Rodbard and R.Mohrherr.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1022-3 (Sept., 1961).

A device has been built which, without requiring intra-arterial puncture, automatically constructs a calibrated upstroke of the arterial pulse wave as well as the durations and intensities of the arterial sounds. The horizontal sweep of a cathode-ray oscilloscope is triggered by the electrocardiogram. The vertical axis is determined by the height of the mercury column in the sphygmomanometer. The vibration amplitude and duration of the acoustic signal are recorded as the brightness and duration of the trace during each cycle.

12705 KOROTKOFF SOUNDS IN HUMANS. J.D.Wallace, D.H.Lewis and S.A.Khalil.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1178-82 (Sept., 1961).

Direct monitoring of Korotkoff sounds from the brachial artex with vascular pressure, cuff pressure, and external sounds has been carried out. Recording of the internal sounds suggests a discrepancy between direct and indirect blood pressure measurement. Examples of spectrograms of the Korotkoff sounds near diastolic pressure are presented.

Hearing . Speech

12706 WHY HELMHOLTZ COULDN'T HEAR MONAURAL PHASE EFFECTS. J.H.Craig and L.A.Jefress.
J. Acoust. Soc. Amer., Vol. 32, No. 7, 884-5 (July, 1960).

It is pointed out that in a recent experiment subjects did in fact detect changes in sound quality between phase-reversed signals. This contradicts a conclusion of Pierce based on work of Schroeder. Attention is drawn to an explanation by Beasley that Helmholtz's failure to detect monaural phase effects was due to the unwieldy nature of his instrumentation. J.Berry

12707 SOME COMMENTS AND A CORRECTION OF "PSYCHOACOUSTICS AND DETECTION THEORY". D.M.Green.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 965 (July, 1961).

Amplifies the use of the term "psychophysical" and explains the scales of pressure and energy used in a previously published paper (Abstr. 18542 of 1960). H.D.Parbrook

12708 ON VOWEL DURATION IN ENGLISH. A.S.House.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1174-8 (Sept., 1961).

Average durations of 12 vowels of American English measu in bisyllabic nonsense utterances are reported. The vowels occurred in 14 symmetrical consonantal environments and the utterances were produced by three male talkers. The consonant environments consisted of the voiced and voiceless versions of three stop, one affricate, and three fricative consonant articulations. Four determinants of the characteristic durations of stressed vowels are identified and discussed. The hypothesis is advanced that the primary lengthening of vowels in English—that found in tense vowels and in vowels before voiced constants is a part of the phonology of the language and is learned by spea of the language, and that the secondary lengthening of vowels in English—that found in open vowels and in vowels before fricativ constants—is a function of the articulatory process itself.

12709 OPERATING CHARACTERISTICS, SIGNAL DETECTABILITY, AND THE METHOD OF FREE RESPONSE. J.P.Egan, G.Z.Greenberg and A.I.Schulman.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 993-1007 (Aug., 1961).

The method of free response refers to the following listenir situation. Against a background of noise, a weak signal is prese several times in a long (2 min) observation interval. The tempo intervals between the presentations of the tones are randomly distributed; consequently, the listener does not know when a ton will occur, and he does not know how many tones will be present From one series of observation intervals to the next, the listene is instructed to adopt various criteria and to press the single response-key each time he "hears a tone." The problem consis in the determination of a procedure that allows the total number of yes responses to be partitioned meaningfully between "hits" a "false alarms." A model is developed in which the measurable quantity, rate of response, is related to the "hit rate" and to the "false alarm rate." Although the criterion adopted by the listen cannot be directly evaluated, the use of a wide range of criteria makes it possible to estimate the detectability d_s of the signal. experiments are described, and the results support the model.

12710 AUDITORY DETECTION OF AN UNSPECIFIED SIGNAL. R.F.Gundy.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1008-12 (Aug., 1961).

Listeners were required to detect an auditory signal agains a background of "white noise". The effects (1) of giving trial-by-information as to whether or not a signal was delivered, and (2) of giving the subject an opportunity to hear the signal before the test sequence began, were studied at two levels of signal energy The results were analysed within the context of the theory of sig detectability. Subjects who were given an opportunity to hear th signal before the test sequence began maintained a stable level of performance throughout the experimental session. On the oth hand, subjects who were given no opportunity to hear the signal performed near chance level at the beginning of the session but showed gradual improvement as trials progressed. The effect o

by-trial feedback was surprisingly small in all groups. Near nd of the session, the signal was demonstrated to all subjects he differences between the groups vanished.

12711 EFFECT OF MATCHING TIME ON PERSTIMULATORY ADAPTATION. A.M.Small, Jr and F.D.Minifie.
oust. Soc. Amer., Vol. 33, No. 8, 1028-33 (Aug., 1961).
Widely divergent amounts of perstimulatory adaptation have reported previously, possibly due to differences in technique easurement. One method often used determines perstimulatory tation from a series of simultaneous binaural loudness balances een a continuous stimulus in the adapting ear and a stimulus mittently presented to the test ear. The present study attempts valuate the effect of the characteristics of intermittency of the stimulus upon the measured adaptation in the adapting ear. a 400 c/s adapting tone presented at 75 dB sensation level, ombinations of on- and off-duration of the test tone were stigated using 11 listeners. For all experimental conditions the ting curves showed the same general shape, with a rapid initial ine, followed by a more gradual decline reaching asymptote after 6 min. As the on-time of the test stimulus increased, less tation was seen, except for off-times of 30 sec or greater e on-time no longer influenced adaptation. This is interpreted dicating that greater amounts of adaptation took place in the ear as on-time was lengthened; but for the stimuli used, 30 sec sufficient for recovery to occur. In general, however, variation n-time produced greater changes in measured adaptation than similar changes in off-time of the test stimulus.

12712 SEQUENTIAL EFFECTS IN THE SIGNAL-DETECTION SITUATION. S.D.Speeth and M.V.Mathews.
coust. Soc. Amer., Vol. 33, No. 8, 1046-54 (Aug., 1961).
This paper examines some sequential effects found in the aviour of observers in the signal-detection situation. The ner–Swets–Green model treats the subject as a stable decision ter operating on information from a noisy but unbiased trans- er. It is suggested that this model may be profitably replaced by in which a bias is introduced by a simple finite-state machine ch makes the subjects' behaviour a function not only of the sent stimuli but also of past stimuli and responses.

12713 STUDIES ON THE AURAL REFLEX. I. CONTRALATERAL REMOTE MASKING AS AN INDICATOR OF FLEX ACTIVITY. W.D.Ward.
Acoust. Soc. Amer., Vol. 33, No. 8, 1034-45 (Aug., 1961).
The phenomenon of "contralateral remote masking" is described elevation of threshold sensitivity to a low-frequency tone in one produced by a high-frequency band of noise in the other. dence is presented indicating that this effect is mainly attenua- n induced by reflex activation of the stapedius muscle, although bably some central masking is also involved. The strength of activation (1) increases linearly with sound pressure level of the usal noise beginning at about 85 dB SPL, (2) decreases linearly h frequency level of the noise, and (3) gradually decreases with e (i.e. adapts), reaching an asymptote after about 3 min. ividual differences in reflex activity could not be explained in ms of differences in resting thresholds. The relation of this enomenon to ipsilateral remote masking and loudness adaptation studied, and its effect on temporary theshold shift and on loudness aptation is studied, and its effect on temporary theshold shift and loudness judgements at high intensities is discussed.

12714 CHANGES IN MASKING WITH TIME. M.Burgeat and I.J.Hirsh.
Acoust. Soc. Amer., Vol. 33, No. 7, 963-5 (July, 1961).
Reports a series of experiments to examine the effects of time remote masking. The effects in threshold change could be shown ally well in the ear receiving the noise and in the ear opposite, icating that the cochlear processes invoked to date to explain note masking are inadequate. The results are examined in the nt of the work by Simmons [Annals of Otology, Rhinology and ryngology (USA), Vol. 68, 1126 (1959)] on the electrophysiological ects of the contraction of the middle ear muscles.
H.D.Parbrook

12715 LOW-FREQUENCY PURE TONE MASKING. A.Finck.
Acoust. Soc. Amer., Vol. 33, No. 8, 1140-1 (Aug., 1961).
Binaural masked thresholds from 50 c/s to 4800 c/s were asured using low-frequency (10, 15, 25, 30, and 50 c/s), high- ensity (100, 115, and 130 dB SPL) pure tones. The results obtained 5 listeners demonstrate a broad masking spread with masking ks for 130 dB SPL pure tones.

12716 NORMALIZED REPRESENTATION OF NOISE-BAND MASKING AND ITS APPLICATION TO THE PREDICTION OF SPEECH INTELLIGIBILITY. S.Saito and S.Watanabe.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1013-21 (Aug., 1961).
Measurements are made of the masking of pure tones by various bands of noise. Curious masking spreads beyond upper frequency limits of noise are observed and these are expressed uniquely by means of the relative masking and the incremental bandwidth. Then the normalized representation of noise-band masking in some restricted ranges is achived and applied for the prediction of speech intelligibility. Predicted articulation scores agree fairly well with measured ones.

12717 ON THE COMBINATION OF INTENSITY AND FREQUENCY DIFFERENCES IN AUDITORY DISCRIMINATION. I.Pollack.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1141-2 (Aug., 1961).
The results of Harris and collaborators [Abstr. 3360 of 1955 and Journal of Experimental Psychology (USA), Vol. 56, 232-8 (1958)] on the discrimination of combinations of auditory intensity and frequency differences were examined with reference to four models of auditory discrimination. Of the four, the most successful prediction of the effect of combinations of intensity and frequency differences assumes a recognizable threshold for each of the stimulus variables.

12718 DEPENDENCE OF SUCCESSIVE JUDGMENTS IN DETECTION TASKS: CORRECTNESS OF THE RESPONSE. E.F.Shipley.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1142-3 (Aug., 1961).
Forced-choice and yes–no auditory detection data were examined for single-trial dependences of the correctness of the response. In both procedures a correct response is more likely when the previous response was correct than when it was wrong. The effect of various characteristics of the signal were studied in the forced-choice procedure: the dependence is more pronounced for higher-intensity signals and for signals of a pure tone rather than for an increment in background noise. An attempt is made to relate these findings to a criterion-correction explanation of the sequential dependence.

12719 SOME POSSIBLE USES OF SINGLE SIDEBAND SIGNALS IN FORMANT-TRACKING SYSTEMS. E.C.Cherry and V.J.Phillips.
J. Acoust. Soc. Amer., Vol. 33, No. 8, 1067-77 (Aug., 1961).
An amplitude-modulated single-sideband waveform can be separated into two parts; an amplitude or "envelope" term, and a frequency-modulation term. Some existing proposals for the use of the frequency-modulation part in speech compression schemes were investigated, and although these schemes were found to be fallacious, some results having possible application to speech formant tracking were obtained.

12720 APPLICATION OF THE THEORY OF SIGNAL DETECTABILITY TO AMPLITUDE DISCRIMINATION. W.P.Tanner, Jr.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1233-44 (Sept., 1961).
The fact that Weber's law appears to apply in the same way both to intensity discrimination for pure tones and to intensity discrimination for white noise poses a theoretical paradox: in the case of pure tones, the human observer becomes less efficient as the intensity of the tone is increased, while in the case of white noise he exhibits a constant efficiency independent of intensity. An inventory of the various possible noise sources which may exist is made, and the way in which these may be effected to effect the detectability of a signal leads to the equation

$$(d')^2 = \eta \frac{2E\Delta}{N_G + N_E + kV_0^2},$$

where η is the individual observer's efficiency, N_G is the noise introduced by the experimenter, N_E is the uncontrolled noise present in the experimental situation, and k is a constant indicating that small amplitude variation in the oscillator constitutes a noise source proportional to the power of the lower of two signals to be discriminated. Data for three observers over four noise levels is described by this equation sufficiently well to suggest that the hypothesis that Weber's law is merely a reflection of the oscillator noise (kV_0^2) is plausible.

Vision

12721 FOVEAL CONTRAST THRESHOLDS WITH BLURRING OF THE RETINAL IMAGE AND INCREASING SIZE OF TEST STIMULUS. K.N.Ogle.
J. Opt. Soc. Amer., Vol. 51, No. 8, 862-70 (Aug., 1961).

Contrast thresholds in foveal vision for circular disks of various angular sizes were measured as the image was blurred by being thrown out of focus. The threshold increased with blurring of the retinal image, but the rate of this increase was less with the larger stimulus disks. The data plot was fitted by an equation developed on theoretic bases, which used the concept of a minimal effective retinal area. The relationship between contrast threshold and size of the stimulus disk was shown to be described by a hyperbola, one asymptote of which was defined by Ricco's law, the other by a constant threshold for larger subtenses of the disk. This relationship was shown to fit adequately the date of other investigators for sharp imagery. With blurring of imagery, the imagery, the thresholds were increased, but below a critical angle, they obeyed Ricco's law. The critical angle increased with increase of blurring. The results are discussed with regard to the optical image on the retina, quasi-independent retinal areas with total or partial summation, and the influence of experimental conditions.

12722 EFFECT OF CONTRAST ON C.F.F. AND APPARENT BRIGHTNESS.
H.Ripps. I.T.Kaplan and I.M.Siegel.
J. Opt. Soc. Amer., Vol. 51, No. 8, 870-3 (Aug., 1961).

Critical flicker frequency (C.F.F.) and apparent brightness of a foveal test field were determined as functions of the luminance of an adjacent inducing field. Apparent brightness measurements were obtained by a binocular comparison method. Inducing luminance was varied through a range of 4.4 log units at each of three test-luminance levels: 0.55, 1.57 and 2.47 log ft-L. The apparent brightness of the intermittent test field, determined at the flicker-fusion threshold, continuously decreased as inducing luminance was raised. C.F.F., on the other hand, varied in a complex manner: increasing initially, reaching a maximum, and then declining. Over a wide range of inducing luminance, the enhancement of C.F.F. was accompanied by a decrease in apparent brightness. This induced divergence is radically different from the parallel changes in C.F.F. and apparent brightness that occur when test luminance is varie It was hypothesised that entoptic stray light played a minor role that spatial inhibition in the retina could account for both the ris and the fall in C.F.F. as well as the concomitant decrease in apparent brightness.

12723 FLICKER FUSION AND HARMONIC ANALYSIS. D.H.Kelly.
J. Opt. Soc. Amer., Vol. 51, No. 8, 917-18 (Aug., 1961).

An interpretation of the flicker-fusion data of Bartley and Nelson (Abstr. 6669 of 1961) in terms of variable retinal illumin tion, which shows the main conclusion deduced by these workers be due to "artifacts of the stimulus wave-form chosen for the experiments". R.A.W

12724 NATURE OF THE TRANSMISSION OF ENERGY IN T RETINAL RECEPTORS. J.M.Enoch.
J.Opt. Soc. Amer., Vol. 51, No. 10, 1122-6 (Oct., 1961).

Waveguide modal patterns were observed in retinal recepto of rat, monkey, and human eyes. Phenomena characteristically occurring in dielectric waveguides were noted. That aspect cons ed here is the appearance of different (or combinations of differ hues when the retina is irradiated with white light of a xenon-ar and the receptor outer segments are viewed. The distribution varies to some degree with angle of incidence of the radiant ene and the phenomenon is present in both rods and cones. It is demonstrated in freshly obtained normal human and monkey cen foveal areas and in some peripheral retinal receptors. Some im cations of these findings are discussed.

12725 BRIGHTNESS AND ACUITY WITH INTERMITTENT ILLUMINATION. J.Nachmias.
J. Opt. Soc. Amer., Vol. 51, No. 7, 805 (July, 1961).

A rebuttal of the criticism of Gibbins (Abstr. 10348 of 1961) R.A.W

12726 WAVEGUIDES AND THE RECEPTOR MECHANISM IN COLOR VISION. A.C.Schroeder.
J. Opt. Soc. Amer., Vol. 51, No. 8, 909 (Aug., 1961).

The use of waveguide terminology in connection with recept optics is criticized on the grounds that the receptor system invo dielectric, not metallic, media. R.A.W

TECHNIQUE . MATERIALS

12727 MEASUREMENT OF RATE OF REMOVAL OF MATERIAL IN GRINDING OPTICAL GLASS.
J.Biesalski.
Hausmitt. Jos. Schneider (Germany), Vol. 13, No. 3-4, 25-34 (1960-61). In German.

The dependence on grinding pressure, speed of tool and size of emery were measured for a number of optical glasses.
W.T.Welford

12728 MULTIPLE LEAD HIGH PRESSURE PLUG. G.J.Scott and S.E.Babb, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 868-70 (July, 1961).

Three thermocouple leads are contained within a high-current lead. The plug has worked satisfactorily up to 7000 bars.
D.Walsh

12729 SIMPLE APPARATUS FOR THE GENERATION OF PRESSURES ABOVE 100 000 ATMOSPHERES SIMULTANEOUSLY WITH TEMPERATURES ABOVE 3000°C.
W.B.Daniels and M.T.Jones.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 885-8 (Aug., 1961).

With the modified Bridgman anvil device described, it is possible to maintain pressures in excess of 100 000 atm simultaneously with temperatures above 3000°C for periods greater than 1 hr. (The fixed points used to infer this pressure are taken to the pressure values established by Bridgman for discontinuitie the electrical resistance of bismuth and barium, 25,650 kg cm^{-2} and 80 000 kg cm^{-2}, respectively, and called the bismuth and ba points. Recent unpublished work indicates that the barium poin pressure will probably have to be revised downward materially reducing the present pressure estimates in the upper range.) T use of an extrudable plastic compressible gasket is described. Several considerations are presented concerning the support of high-pressure components constructed of cemented tungsten ca bide. Coesite, almandite, and diamond have been synthesized i apparatus.

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Vol. 64 (1961). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Analyst (GB)	Analyst [Abstracted by Copper Abstracts].
Bull. Inst. Internat. Statist.	Bulletin of the Institute for International Statistics [Abstracted by Mathematical Reviews].
Dept. Mines Tech. Surveys, Ottawa, Mines Branch Res. Rep. (Canada)	Department of Mines and Technical Surveys, Ottawa, Mines Branch Research Report [Abstracted by Copper Abstracts].
Izv. Akad. Nauk, Otdel. tekn. Nauk (USSR)	Izvestiya Akademii Nauk Otdelenie Tekhnicheskikh Nauk Akademiya Nauk SSSR, Lenin Prospekt, Moscow.
J. appl. Mech. (USA)	Journal of Applied Mechanics American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y.
Machinery (GB)	Machinery [Abstracted by Copper Abstracts].
Metallurgia (GB)	Metallurgia [Abstracted by Copper Abstracts].
Prod. Engng (USA)	Product Engineering [Abstracted by Copper Abstracts].

NEW JOURNAL

Philips Res. Rep. Suppl. (Netherlands)	Philips Research Reports. Supplements Philips Research Laboratories. Subscription Address: N.V. Uitgeversmaatschappij Centrex, Cederlaan 2, Eindhoven.

ERRATA

Abstr. 3718 (1960) line 4 : for "V.P.Shchestopalov" read "V.P.Shestopalov".
Abstr. 8747 (1960) line 2 : for "A.Urosovskii" read "I.A.Urosovskii".
Abstr. 11339 (1960) line 2 : for "Yu.I.Fillimonov" read "Yu.I.Filimonov".
November (1960) p. 1672, col. 1: abstract numbered "15959" should read "16959".
Abstr. 10953 (1961) line 2 : for "Yu.B.Tsekhmistrenko" read "Yu.V.Tsekhmistrenko".
Abstr. 11116 (1961) line 3 : for "R.Lefevre" read "R.Lefebvre".
Abstr. 11337 (1961) line 15: for "KH_2PO" read "KH_2PO_4".
Abstr. 11355 (1961) line 8 : for "cinchomine and cinchoridine" read "cinchonine and cinchonidine".
Abstr. 11409 (1961) line 1 : for "ZINC AND SULPHIDE PHOSPHORS" read "ZINC SULPHIDE PHOSPHORS".
Author Index (August, 1961): Hughes,N.D.P. and Moss,T.S.: for "9368" read "9268".

AUTHOR INDEX

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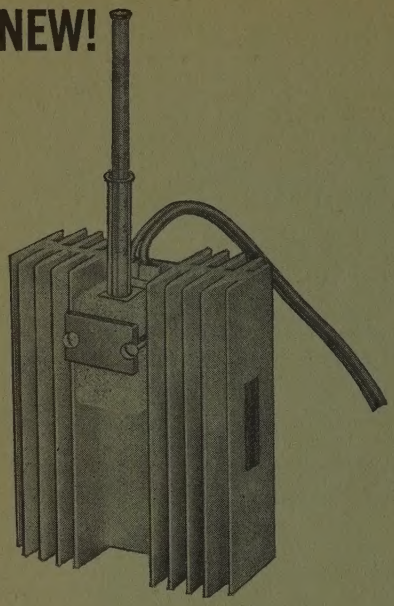

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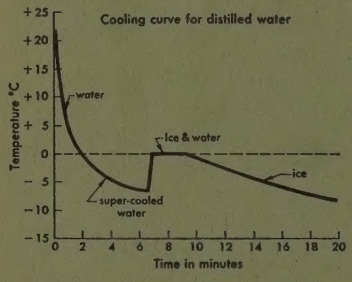

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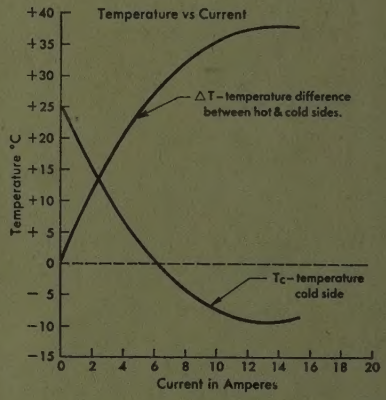

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